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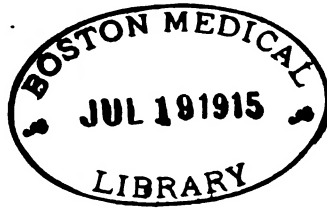
OTHER DISEASES OF THE VERMIFORM APPENDIX

BY
HOWARD A. KELLY, M.D.

*WITH 215 ORIGINAL ILLUSTRATIONS, SOME IN COLORS
AND 3 LITHOGRAPHIC PLATES*



PHILADELPHIA AND LONDON
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Fig 1



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Fig 3



Fig 4



Fig 5

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DESCRIPTION OF PLATE I.

FIG. 1.—Acute appendicitis with superficial ulceration. The proximal third (*a*), apart from two or three pinpoint ulcers, is fairly normal. A similar condition is noticed in the distal portion of the mucosa (*c*). The median portion (*b*) is hemorrhagic and shows more extensive ulcerations. The tip (*d*) is obliterated. With the hand lens the ulcers are found to occupy the centre of a system of Lieberkühn's crypts, and correspond to the normal position of the lymph nodes.

FIG. 2.—Chronic appendicitis. The appendix is thickened, rigid, and markedly injected.

FIG. 3.—Mild acute catarrhal appendicitis. The serous covering is slightly injected.

FIG. 4.—Typhoid appendix. End of second week. The appendix is swollen, erect and tense, and hyperæmic.

REPORT ON PLATE I.

FIG. 1.—A. The appendages with abdominal articulation. The posterior appendage is from two or three pairs of abdominal articulation. A similar structure is found in the distal portion of the minute (A). The median portion (B) is homologous with the 2nd abdominal articulation. The (C) is differentiated. It is the most lateral of the three, and occurs in the center of a group of Lachmann's organs, and corresponds to the normal position of the lymph node.

FIG. 2.—Chronic appendicitis. The appendix is thickened, rigid, and markedly inflamed.

FIG. 3.—Acute appendicitis. The serous covering is slightly inflamed.

FIG. 4.—Tubercular appendix. End of second week. The appendix is swollen, erect and tense, and is permeated.

THE HISTORY OF PLATE II

[illegible]

DESCRIPTION OF PLATE II.

FIG. 1.—Acute appendicitis, thirty-six hours. The appendix slightly enlarged, tense and injected. At the tip a small gangrenous area surrounded by a dark colored hemorrhagic area. No adhesions.

FIG. 2.—Acute appendicitis. The appendix swollen and congested. The gangrenous distal third bent at an obtuse angle by a band of adhesions.

FIG. 3.—Gangrenous appendicitis, forty-eight hours. The appendix greatly enlarged, total gangrene of the distal third, and irregular areas of gangrene in proximal portion. Near the middle the canal is distended with a round, hard concretion. Masses of fibrin and a few old adhesions on the surface.



Fig. 1



Fig. 2



Fig. 3

**THIS
PRACTICAL HANDBOOK
ON
APPENDICITIS AND OTHER DISEASES
OF THE VERMIFORM APPENDIX
IS DEDICATED TO MY
MANY FRIENDS AMONG THE
GENERAL PRACTITIONERS IN AMERICA**

PREFACE

I ENDEAVORED in preparing the first edition of my work on *The Vermiform Appendix and its Diseases* in conjunction with DR. HURDON to make that work a great storehouse of well-digested facts relative to the protean diseases of this little organ. It soon, however, became evident that a compact *résumé* dwelling with especial care on the practical side of the subject would better meet the daily needs of the great army of general surgeons throughout the country. With that end in view I have prepared this new edition.

Chapter XII, on the *Leucocytes in Appendicitis*, has been written by DR. CHARLES SIMON, and is the condensation of a vast amount of clinical work and personal investigations, especially in the discussion of the septic factor, which is original with DR. SIMON.

DR. WALTER L. BURRAGE has revised the clinical section and added one on Senile Appendicitis, DR. LATIMER has prepared the book for press, and MISS DAVINA WATERSON has read the proofs.

HOWARD A. KELLY.

PHILADELPHIA, January, 1910.

PREFACE TO THE FIRST EDITION

THE present work is the outcome of an investigation undertaken some years ago when I first began to notice the conditions of the appendix in every abdominal operation, an undertaking which soon grew to unexpected proportions. The literature of the subject is so extensive that I fear I may not have done full justice to the many faithful workers in the field; indeed, even as the pages are passing through the press several valuable articles have appeared too late for recognition.

Under the conviction that surgery and pathology are best taught by demonstration, I have tried to parallel the text with graphic illustrations, and in a few instances the figure with its legend stands alone. I acknowledge here my indebtedness to MR. HORN, MR. BRÖDEL, MISS HUNTINGTON, and MR. BECKER for their splendid artistic work; the enthusiasm with which they have entered into various researches and prosecuted every phase of their work has greatly enhanced my own pleasure and satisfaction. The anatomical chapters were written by MR. BRÖDEL and illustrated, for the most part, by MISS RUTH HUNTINGTON, now MRS. BRÖDEL.

I will avail myself of this opportunity to say a few words relative to the illustration of medical works and the proper use of good figures.

The changes in the appearance of an organ brought about by disease are often manifested in such delicate deviations from the normal topography that it requires the hand and eye of a genuine artist, and one who is also a well-informed anatomist and careful pathologist, to represent the morbid condition accurately. The sense of vision, when unaided, often fails to grasp the significance with completeness, and in such a case the true artist will palpate the fresh specimen and then represent the combined results of sight and touch. The superficial structure alone is frequently insufficient to demonstrate the character of the specimen, and the artist must find means of exhibiting the surface relations in association with the interior. This can be done: (1) by inserting lines, (2) by cutting away portions of the surface and thus displaying the depth, (3) by magnifying the organ and drawing it as though translucent, and (4) by explanatory diagrams, cross-sections, etc.

From these considerations it is evident that an intelligent interpretation of a pathological specimen or of an anatomical or clinical demonstration through the eye and hand of a trained scientific artist must be vastly superior as a means of instruction to the best photograph. Yet how often when we appeal to an illustration for light on a difficult text do we find a

hazy, woolly, milky, or coarse drawing, which only succeeds in leaving our confusion worse confounded.

Good, true illustrations are a most valuable handmaid in medical instruction, for what the eye of the student has grasped remains, as old Horace memorably said, indelibly impressed after a fashion unequalled by the clearest verbal description. I would beg the reader, therefore, not to be satisfied with glancing hurriedly over these illustrations and their legends, returning at once to the text, but to study each figure with care.

The essential feature, its centre of interest, is generally emphasized by greater contrast in shading, by which the attention of the observer is insensibly focussed. The differences in the tone value of the peritoneum over the small and large intestine, and of the fat, adhesions, etc., are given in a manner as realistic as is possible in black and white drawings. Cysts are made translucent as in the fresh condition. The method of making our originals, whether pen and ink, half-tone, or color, has been selected with a view to the use for which the picture was designed. A simple topographical relationship is best shown by line drawing, and steps in an operation, half schematically represented, are done in pen and ink. For anatomical and pathological characteristics where delicate surface structures and plastic effects are required, we have used wash drawings adapted for half-tone reproduction.

In the microscopic pictures even the individual cells have been drawn with the utmost fidelity; in no case have they been schematized. Many of the pictures will be best appreciated if studied with a low-power hand lens.

I will here ask the reader to correct the reference on page 93 from p. 183 to p. 186.

One of the pleasantest parts of my task has been the fact that I have been constantly dependent upon the good offices of willing friends.

DR. CAROLINE LATIMER has been my faithful aid from the beginning, revising the English of the manuscript and caring for it and for the proof in all stages, besides assisting in various other ways too numerous to mention. Her own original labors will be found in the historical chapters, upon which she has spent months of enthusiastic effort.

DR. HENRY CHRISTIAN, one of our own graduates, now of the Boston City Hospital, has contributed the chapter on autopsy findings.

DR. WILLIAM A. FORD, of the Johns Hopkins Hospital, wrote that on the bacteriology of the appendix and cæcum.

My friend, DR. HARVEY CUSHING, wrote the section relating to cocaine anæsthesia in the chapter on preliminaries to operation.

My colleague, DR. HALSTED, from the first graciously placed the entire material of his large surgical service at my disposal. I am also glad to acknowledge my debt to DR. J. M. T. FINNEY and the other members of the surgical staff; the extent to which they have aided me is in evidence everywhere throughout the text.

My associate, DR. GUY L. HUNNER, has helped me in revising the chapters on treatment.

I am indebted to DR. J. ERLANGER for assistance in carrying out the physiological experiments described in Chap. VIII.

Many friends, notably DR. MAURICE H. RICHARDSON, of Boston, DR. ROBERT ABBÉ, of New York, and DR. J. B. MURPHY, of Chicago, have been most kind and patient in answering numerous and, I fear, often troublesome letters of inquiry.

I have to thank DR. JOHN B. DEAVER, of Philadelphia, for the use of his large stock of material, as well as DR. A. O. J. KELLY.

DR. HENRY ELSNER came to my aid in the chapter on appendicitis in typhoid fever.

Every one who has had to consult many books in the preparation of a large work will realize the extent of my obligations to DR. ROBERT FLETCHER, and also, especially, to the late DR. J. E. MERRILL, in my necessary use of that monumental foundation of J. S. BILLINGS, the Surgeon-General's Library.

The section on leucocytosis is not so comprehensive as I had intended, but I hope to enlarge and extend it in a subsequent edition.

In conclusion, let me thank all my friends, at home and abroad, for specimens, notes, and drawings, as well as for the genial atmosphere of cordial interest with which they have invested the subject from the beginning.

Lastly, I would call attention to the index of names. It has been one of the pleasantest features of the work to realize, as I culled these from the text, the truth of that inspired declaration of the great apostle to the Gentiles: "Others have labored, ye have entered into their labors."

HOWARD A. KELLY.

ELIZ. HURDON.

BALTIMORE, January 23, 1905.

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APPENDICITIS

AND

OTHER DISEASES OF THE VERMIFORM APPENDIX

CHAPTER I.

HISTORY.

A KNOWLEDGE of the morbid conditions affecting the vermiform appendix belongs exclusively to the nineteenth century. Occasional descriptions of disease in its structure or of abnormalities in its size, shape, and position are found in autopsy records of an earlier date, but such instances were regarded simply as curiosities and excited no especial comment beyond a passing conjecture as to a possible relationship between the lesion and its associated symptoms. Lords

The earliest definite anatomical record of disease in the appendix has recently been brought to my notice by my friend, Dr. E. J. Ill, of New Jersey. It was reported by LAWRENCE HEISTER in 1755. ("Med., Chir. and Anat. Cases and Observations." Translated from the German ed. (1753) by G. Wirgman. J. Reeves, Lond., 1755, p. 102). "In the month of November, 1711," the report reads, "as I was dissecting the body of a malefactor in the public theatre at Altdorff, I found the small guts very red and inflamed in several places, (insomuch that the smallest vessels were as beautifully filled with blood as if they had been injected with red wax, in the most skilful manner, after Ruysch's method.) But when I was about to demonstrate the situation of the great guts, I found the vermiform process of the cæcum preternaturally black and adhering closer to the peritoneum than usual. As I was about to separate it by gently pulling it asunder, the membrane of the process broke, notwithstanding the body was quite fresh, and discharged two or three teaspoonfuls of matter. This instance may stand as a proof of the possibility of inflammation arising and abscesses forming in the appendix as well as in other parts of the body, which I have not observed to be much noticed by other writers, and when in practice we meet with a burning and pain where this part is situated we ought to give attention to it. It is probable that this person might have had some pain in this part, but of this I could get no information."

The first reported case of appendicitis observed during life is the classical one of MESTIVIER in 1759 (*Jour. de méd., et chir., et phar.*, 1759,

vol. 10, p. 441). A man of forty-five sought relief for a tumor in the right side of the umbilical region. Fluctuation could be detected and about a pint of pus was evacuated by incision. The wound healed readily, but the patient died suddenly shortly after the operation, and at the autopsy the cæcum was found covered with patches of gangrene, but otherwise presenting nothing abnormal. The vermiform appendix contained a large
 X pin, very rusty, and so corroded in places that the least touch would have broken it. "It is easy to understand," continues the report, "that, although the patient had never spoken of swallowing a pin, the one in question had been concealed for a long time in the vermiform appendix of the cæcum, and that it was undoubtedly this which had irritated the different coats of which the organ is composed and given rise to all the patient's symptoms, finally causing the death which ensued." ←

In the year 1766 a medical student, JOUBERT LAMOTTE, published a paper entitled "Ouverture du cadavre d'une personne morte d'une tympanite" (*Jour. de méd., et chir., et phar.*, vol. 24, p. 65). The patient in question died with supposed intestinal obstruction, and at the autopsy
 X the appendix and the cæcum were found filled with what were supposed to be cherry-stones, and were evidently the first fecal concretions on record. The "Encyclopédie méthodique," issued in 1790, contains an incidental reference to a foreign body, evidently a fecal concretion, formed around a hair, found in the appendix of a patient dying of disease of the lungs.

With the advent of the nineteenth century the appendix began to be more frequently mentioned. In 1808 JADELOT reported the case of a boy who died of an "adynamic fever," where lumbricoid worms were found in the appendix at the autopsy (quoted by F. MÉLIER, "Mémoire
 X et observations sur quelque maladies de l'appendice cæcale," *Jour. gén. de méd., chir. et phar.*, Paris, vol. 100, p. 342). In 1812 a London physician, PARKINSON (*Med. and Chir. Trans.*, Lond., 1812, vol. 3, p. 57), published the case of a boy of five, who died of an attack of what was evidently acute appendicitis, and the autopsy showed a perforation of the appendix. This is the first case in which perforation of the appendix is recognized as the cause of death.

The earliest attempt to treat the subject on a scientific basis is in a report made by WEGELER in 1813 (*Jour. de méd., et chir. et phar.* 1813, vol. 28, p. 384), in which the foreign bodies found in the appendix were subjected to a chemical analysis. This paper attracted some attention and was the subject of discussion at a medical meeting in Paris.

In the year 1824 there appeared an article by a Frenchman, LOUYER-VILLERMAÏ, which at once established a definite place for lesions of the appendix in the category of recognized diseases (*Arch. gén. de méd.*, 1824, vol. 5, p. 246). It contains the report of two cases in which both patients died after a brief illness characterized by violent pain in the right side of the abdomen, and vomiting. In both autopsies the appendix was found gangrenous. The writer observes that the cases appear to belong in the

same category and that the autopsies, although there are some minor differences, reveal the same fundamental lesion of the same organ, the appendices being affected in a similar manner; and in conclusion he asks: "but how could the inflammation of an organ of such small size and more especially of such limited importance occasion death so rapidly and without causing peritonitis? We are equally in the dark as to whether disease of this organ will always be followed by results as speedy and as disastrous."

A month after the appearance of Villermay's paper a similar case was reported in England by BLACKADDER (*Edin. Med. and Surg. Jour.*, 1824, vol. 18, p. 240) in which a man of forty-five fell suddenly to the ground in a state of collapse without premonitory symptoms of any kind and died three and a half hours afterwards. The postmortem showed that the heart was much dilated, with a clot of blood extending nearly to the arch of the aorta. The abdominal viscera were healthy, except the vermiform appendix, which was remarkably increased in length and thickness, its cavity being filled with a lumbricoid worm. Blackadder considered that the irritation produced by the worm occasioned a spasmodic contraction of the abdominal muscles which caused death by impeding the action of the already diseased heart.

Three years later, in 1827, another Frenchman, MÉLIER, published an article so full of thought and insight that it might well have marked an era in the history of the subject, had the writer possessed the courage of his convictions and had he been able to withstand the force of adverse opinion expressed by DUPUYTREN, the great surgical authority of the time. MÉLIER cites five cases of acute disease, two of which are those of VILLERMAY just mentioned, and points out that, as all five of the cases occurred within a comparatively short time and two were in the practice of the same physician, the condition was not probably so rare as it was supposed to be. He then proceeds to apply the knowledge gained from these acute cases to the chronic form of the disease, hitherto unnoticed, and cites a case in point where the autopsy showed an immense abscess to which a part of the cæcum together with the vermiform appendix was adherent, the latter communicating directly with the abscess cavity. "In comparing this case," says MÉLIER, "with the preceding ones, I am constrained to believe that here also the appendix cæci was the original source of evil; that there had been a collection of fecal matter in its cavity, perhaps even a stercoral calculus, and that the appendix, acutely inflamed, had become adherent to the peritoneum, the adjacent cellular tissue becoming engorged and an abscess forming in consequence of the perforation of the appendix." Could there be a clearer recognition of the causal nexus between disease in the appendix and chronic suppuration affecting the right iliac fossa?

MÉLIER is undoubtedly entitled to the distinction of first recognizing this causal relationship; furthermore, he was sufficiently in advance of his generation to suggest the possibility of surgical interference in such affections. "If it were possible," he says, "to establish the diagnosis of

X these affections in a certain and positive manner and to show that they were always entirely circumscribed, the possibility of an operation might be conceived; some day, perhaps, this result will be reached." To MÉLIER, therefore, belongs the credit of first formulating correct conclusions as to the existence of inflammation of the appendix in a chronic form; of recognizing the causal relationship between this chronic affection and suppurative tumors in the right iliac fossa; and, lastly, of first suggesting the possibility of surgical interference in such conditions. With the establishment of these points the first stage in the evolution of knowledge concerning the vermiform appendix is complete: the possibility of primary lesions in the organ is established and they are admitted to a definite place in the category of recognized diseases.

In spite of this good beginning, the further development of knowledge on this subject was slow and uncertain, owing mainly to great misdirection of effort. MÉLIER's views, which, if adopted, would have opened up the whole subject, failed of acceptance, mainly because the most important surgeon of the time, DUPUYTREN, took an opposite position, stating emphatically that the reason why abscess in the iliac fossa was found on the right side rather than on the left lay in the structure of the ileocaecal valve and of the caecum. The theory that suppurative tumors in the right iliac fossa arose from caecal disturbance of one kind or another thus became fully established and remained dominant for over half a century.

Investigation into the subject, however, was now stimulated, and reports of primary lesions in the appendix increased rapidly until the frequency rather than the rarity of such lesions became established. During the first thirty years of the nineteenth century all interest in the vermiform appendix centred in France and England, but in the year 1830 a student of PUCHELT, GOLDBECK, published an inaugural dissertation (Worms) on tumors in the right iliac fossa, which stimulated inquiry in Germany just as it began to decline in France, and for the next twenty-five years all important communications upon the subject proceeded, with few exceptions, from the former country, although, as their writers were ignorant of the interpretation of the symptoms they described, it is necessary to read between the lines to discover the mine of information contained in them. The clinical picture of inflammation of the appendix drawn by GOLDBECK would answer for a description of appendicitis to-day, but both he and his master PUCHELT were so far from a right understanding of the significance of the symptoms they described that GOLDBECK says he is at a loss for an explanation of them, and that the reason suppurative tumors make their appearance on the right rather than on the left side of the abdomen is one for consideration.

During the period of time when Germany occupied such prominence in the literature of the appendix, four important contributions to it appeared in England: by COPLAND, by HODGKIN, by BRIGHT and ADDISON, and by BURNE. To COPLAND belongs the credit of first discriminating

between inflammation of the appendix, inflammation of the cæcum, and inflammation of the pericæcal tissue; moreover, he is, I believe, the first person to include blows and violent exertion among the exciting causes of disease in the appendix. The papers by HODGKIN and by BRIGHT and ADDISON contain excellent descriptions of the condition in question as observed upon the autopsy table, descriptions so clear and well presented that they could not be surpassed to-day. BURNES's papers (*Med. and Chir. Trans.*, 1837 and 1839) have always received much consideration and his name is closely associated with the early history of appendicitis. A dispassionate estimate of his work, however, shows that its value has been greatly overestimated; moreover, he actually hindered progress by the introduction of the term "tuphlo-enteritis." The unfortunate name "perityphlitis," invented by GOLDBECK and his master PUCHELT, had already diverted attention from the organ really at fault; "typhlitis," suggested by ALBERS in 1838, did so still more; and finally "tuphlo-enteritis," in line with the extraordinary gastro-enteric pathology of the day, appeared to lead inquiry still farther astray. A paper which appeared in France at this date by GRISOLLE (*Arch. gén. de méd.*, 1839, vol. 4, pp. 34, 137, 293) has also been much too highly praised, as may be seen from the fact that in an analysis of seventy cases of iliac tumor he does not distinguish between those upon the right and left sides nor does he exclude those arising after parturition. X

In the year 1837 the first American contribution to the history of the appendix appeared. WOLCOTT RICHARDS, of Cincinnati (*West. Jour. of Med. and Phys. Sci.*, 1837, vol. 11, p. 376), published a case in which the patient, a man of thirty-five, had a distinct chill followed by fever, but without pain or vomiting. On the fifteenth day he died in sudden collapse, and the autopsy showed a general peritonitis with recent adhesions, while the pelvis was filled with fecal matter issuing from a large ragged perforation in the appendix. Dr. RICHARDS comments upon the fact that not only vomiting but abdominal pain and tenderness were absent during the entire illness, and only after the final change for the worse was there extreme tenderness in the hypochondrium with slight distention. In the next year a similar case was reported in Philadelphia by EDWARD HALLOWELL (*Amer. Jour. Med. Sci.*, 1838, vol. 22, p. 127), and these two cases with four others were all that appeared upon the subject in the United States for nearly twenty years.

The most important contribution to the knowledge of the appendix which appeared between the years 1840 and 1860 is a thesis by ADOLPH VOLZ, "Die durch Kothsteine bedingte Durchbohrung des Wurmfortsatzes, die häufig verkannte Ursache einer gefährlichen Peritonitis" (Karlsruhe, 1846). The avowed purpose of the thesis is to advocate the treatment of perforation of the appendix with opium. Volz doubts whether perforation occurs (exclusive of cases resulting from tuberculosis or typhoid fever) from any cause other than a fecal concretion, and he cites forty-one cases in which, after an illness characterized by all the symp-

toms of abdominal inflammation, the appendix was found perforated by a body of this kind; he divided these into three classes according to their consistency, soft, hard, and medium (*halb-feste*). The fact that such concretions resemble fruit stones and are often mistaken for them is here noted for the first time. Moreover, Volz points out that the condition known as perityphlitis is not a primary one, but secondary to inflammation of the vermiform appendix, and he also distinguishes plainly between the suppurative and non-suppurative forms of the affection, dividing the suppurative variety into two classes: one in which the pus discharges into the abdominal cavity, exciting a general peritonitis; and another where the abscess, circumscribed by adhesions, burrows in different directions according to the efficiency of the protective barriers which it encounters.

The antiphlogistic treatment of appendicitis then in vogue Volz characterizes as irrational and brutal, expressing a hope that the time would come when the principle of rest for the intestines by means of opium will be as clearly recognized as the same principle applied to-day to a broken leg by means of splints, a happy parallel which he carries out with ingenuity and humor. In conclusion, Volz makes some far-sighted remarks on peritonitis in general, manifesting an insight far in advance of his time, and maintaining that almost all inflammations of the peritoneum have their origin in injuries or displacements of the abdominal organs, and of all the organs in question the appendix is most frequently at fault. He further insists that the so-called idiopathic peritonitis is simply one in which our knowledge is insufficient to show us its local starting-point. The thesis, as a whole, is certainly the most thoughtful and comprehensive treatment of the subject up to the time of its publication.

The year 1838 was distinguished by the first operation for disease of the appendix as such. The aggressive surgery of the appendix as practised to-day is a development of the last twenty-five years, but the incision and evacuation of old encysted collections of pus in the right iliac fossa was practised as far back as the beginning of the Christian era. Their treatment by incision and drainage at the point of fluctuation was practised and taught by DUPUYTREN, but the idea of incising the tumor before fluctuation appeared did not occur to him or his followers.

The first decisive step in the direction of modern methods was taken by a London physician, HANCOCK (*Lancet*, 1848, vol. 2, p. 380), who, after making a diagnosis of inflammation of the appendix, incised the mass in the right iliac fossa without waiting for fluctuation to appear. Upon opening the abdomen a quantity of turbid serum poured out, mixed with bubbles and patches of false membrane. This discharge continued for some days quite freely, and on the fifteenth day two fecal concretions were found in the wound. From this time the patient improved and ultimately recovered.

Another case of special interest from the operative point of view, which seems to have escaped the notice of the medical historian, was

reported in 1850 by another English physician, GAY (*Proc. Path. Soc.*, London, 1850-51). The patient had had a number of attacks of abdominal pain within five years, all accompanied by constipation and vomiting, the symptoms disappearing after a free evacuation of the bowels. In the final attack, when GAY was called in, there was every indication of intestinal obstruction, and accordingly the abdomen was opened under chloroform narcosis. It was found that about fifteen inches of small intestine had become incarcerated behind the adherent appendix. This was liberated without difficulty, and the patient did so well that he might have recovered had he not risen from bed in defiance of instructions to the contrary, and the exertion was followed by his death in a few hours. The autopsy showed the appendix adherent above the cæcum in such a manner as to form a complete ring through which the intestine had passed. It was obvious that the symptoms for which the operation was performed arose from one of the late sequelæ of inflammation of the appendix, and it is, I believe, the first occasion on which the abdomen was opened and the diseased appendix exposed to view.

In 1858 GEORGE LEWIS, of New York State, published a paper which deserves mention because it is the first systematic contribution to the literature of the appendix in the United States (*N. Y. Jour. Med.*, 1856, ser. 3, vol. 1, p. 328). It shows remarkable insight and clearness and deserves to be ranked among the early contributions of permanent value to the subject.

By the middle of the nineteenth century the true nature of disease of the appendix began to be recognized by the medical profession in general, as shown by a glance at the literature of the period. The obstacles which had blocked the progress of knowledge gradually disappeared, and after the year 1860 disease of the appendix became more and more a question of surgery. In 1867 WILLARD PARKER, of New York, published a report of four cases in which he treated abscess in the right iliac fossa consequent upon inflammation of the appendix, by incision and evacuation. The first three cases, which occurred at intervals during the next twenty years preceding PARKER's report, were operated upon after fluctuation had appeared, but during this period PARKER became convinced that it was not necessary, nor even desirable, to wait for fluctuation before making an incision, and the last of these four cases offered him an opportunity to put his theory to the test. The conclusions which PARKER drew from this successful experiment were that nature attempted in such cases to protect life by building a wall of adhesions around the abscess but that ulceration of this protective wall might give exit to the contents. The question for the surgeon to consider, therefore, was, what could be done to assist nature in her efforts and at what period would his assistance be most useful. In PARKER's opinion, the best time for the incision is between the fifth and the twelfth days, that is to say, after the adhesions are fully formed and before the maximum amount of pus is reached. The case in which PARKER put his theory to the test was operated upon on the

sixth day, when there was an area of circumscribed tenderness in the right iliac fossa, but no definite swelling, still less, fluctuation. An incision was made through the skin, beginning about an inch above the anterior superior spine and extending for about six inches toward the symphysis. As soon as the transversalis muscle was reached the tumor could be felt, and it was freely opened, about four ounces of pus being evacuated. A tent was then inserted and the wound left to heal by granulation.

PARKER's paper at once provoked discussion in many quarters, and the method he employed came into general use as the "Willard Parker operation." The medical profession had by this time acquired the anatomical and pathological knowledge necessary for many similar advances, and the only thing needed to inaugurate a new era in the treatment of the disease was a guarantee of safety in operation. During the year following the appearance of PARKER's paper this fundamental necessity was supplied in the principle of antiseptics, introduced into surgery by Sir JOSEPH LISTER, and the surgical history of the appendix began.

The rapidity with which the treatment of inflammation of the appendix advanced along surgical lines is shown by the fact that in 1873 the number of cases treated by incision before fluctuation was eight (W. T. Bull, *N. Y. Med. Soc.*, 1875, vol. 18, p. 240) exclusive of Hancock's, which is not mentioned. A similar list published by J. W. S. Gouley in 1875 (*Trans. Path. Soc. New York State*, 1875, p. 346) shows an increase of nineteen cases during two years between the appearance of the two papers. In 1883 a third list, published by Noyes (*Trans. Rhode Isl. Med. Soc.*, 1883, vol. 2, pt. 6, p. 495), gives eighty-four cases of early incision and evacuation since Parker's in 1867, and, if we subtract the twenty-eight cases published in previous lists, we find fifty-six for the eight years between the appearance of the two papers, that is to say, between 1875 and 1883.

It is also of interest to note here the reduction in mortality after the introduction of PARKER's operation. In 1867 the death-rate from inflammation of the appendix, under the non-operative treatment, was forty-seven per cent., while in 1882, when PARKER's operation had been in use for fifteen years, it was reduced to fifteen per cent.

Up to the time we have now reached, that is to say, the early eighties, incision before the detection of pus was the most daring procedure which surgeons had ventured to propose, but the time had now come when a much more radical measure was to be adopted and the actual removal of the appendix became the point upon which the eyes of the surgical world were focussed.

In 1884 Professor MIKULICZ, of Krakow (*Samml. klin. Vorträge*, 1885, p. 262), urged that laparotomy should be performed for every species of non-traumatic perforation of the stomach or intestines if it could be done soon enough; and that, in any case of peritonitis the original cause of which was not clear, the region of the cæcum ought to be investigated and a possible perforation of the appendix suspected.

The operation urged by MIKULICZ was performed for the first time in the same year (1884) by KRÖNLEIN, of Germany (*Arch. f. klin. Chir.*, 1886, vol. 33, p. 507). The patient, a boy of seventeen, was suddenly attacked by pain in the right ileocæcal region, followed by vomiting which assumed a fecal character after twenty-four hours. When seen by KRÖNLEIN on the third day, he was in a state of collapse, and examination of the abdomen showed a painful area over Poupart's ligament on the right side. A diagnosis was made of "either perforative peritonitis originating in the vermiform appendix or an occlusion of the intestines." Operation showed the appendix to be freely movable but much infiltrated; it had a perforation the size of a pea at its middle portion, the edges of which were gangrenous, while some fecal concretions lay loose in the perforation. The appendix was ligated with a double ligature and resected *in toto*, the peritoneum carefully cleansed, and the abdominal incision closed without drainage. The patient did well for twenty-four hours, but at the end of that time the symptoms returned and he died three days after the operation. No autopsy was permitted.

This operation, although performed in 1884, was not published until 1886, but, as no other operation for removal of the appendix was reported in the interval, it remains the first instance of cœliotomy followed by resection of the appendix both as to date of performance and date of publication.

In 1885 an English surgeon, CHARTER SYMONDS, performed what is certainly the first interval operation for appendicitis, though it is not an operation at all according to our modern ideas of such procedures. The patient, a man of twenty-three, had repeated attacks of inflammation in the right iliac fossa and was suffering with one of them when admitted into Guy's Hospital. Examination showed a small, hard, tender lump in the right groin, and a diagnosis of appendicitis was made by Dr. MAHOMED, who stated his belief that there was an abscess with a fecal concretion and that the recurrent attacks were due to periodical occlusion of the communication with the cæcum. Dr. MAHOMED advised operation when the acute symptoms should have subsided and planned the manner of its execution; he died, however, before the time came to act upon his idea, and Mr. SYMONDS performed the operation according to his intention. The incision was that used for ligating the external iliac artery. The various structures were then divided, with particular care to avoid opening the peritoneum, until a lump was plainly felt. An incision was then made into the mass and a calcareous body exposed and removed. No pus was seen and the cavity from which the calculus was removed seemed smooth and free from other materials. The soft and purplish lining was evidently mucous membrane, and the tortuous cord-like appendix could be distinctly traced, so that there was no doubt that it had been laid open. The opening was closed and a large drainage tube inserted. The peritoneum was not recognized and not opened. The patient recovered ultimately, though troubled for some time by a fecal fistula.

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 In the next year, 1886, an article appeared in America which cleared up the entire subject of disease of the appendix and created an epoch in medical and surgical history. REGINALD FITZ, of Boston (*Amer. Jour. Med. Sci.*, 1886, vol. 92, p. 32), the writer of the paper, has done more than any other one man to bring about a right understanding of the morbid conditions affecting the vermiform appendix. The essential point which FITZ grasped, and which up to that time had escaped the most astute observers, was that all the various abdominal disorders known as perityphlitis, typhlitis, cæcitis, etc., which had always been separately considered and treated, were really nothing but the different manifestations of a morbid process originating in the vermiform appendix, and that the differences in the clinical history of these disorders were due to variations in the size, patency, and position of the appendix itself. He speaks most emphatically upon the necessity for prompt surgical interference, pointing out that it should be employed much earlier than had hitherto been the case. A table of sixty fatal cases collected by him shows that the fifth day, recommended by Parker, was too late to afford relief in more than one-fourth of the cases. "Hence," he says, "if the indications for operation justify the election of a date as early as the fifth day, they still more justify the choice of the third day. The result of the wisdom of the former step and the evidence here presented seems not only to warrant but to demand the latter. It is evident that the operation to be performed is that of opening the abdominal cavity. It is unnecessary to state that an action which twenty years ago might have added to the risks of the patient may at the present time, when properly performed, be confidently expected to reduce them materially."

It is in this paper that the word "appendicitis" appears for the first time, quite incidentally and without formal introduction, the writer speaking of perforative inflammation on one page and of appendicitis on another and using the terms interchangeably throughout the remainder of the article. Dr. FITZ himself says, of the introduction of the term, "The word was coined by me for practical purposes. I wished to call attention to inflammation of the vermiform appendix as the primary lesion and that to which it was directly to be applied."

This paper, like that of Parker twenty years before, appeared at the right moment. The medical profession at this time stood in an expectant attitude, and required only this demonstration of the subject to accept the transfer of disease of the vermiform appendix from the domain of internal medicine to that of surgery. No sooner was this done than they began to develop operative procedures which, in their turn, supplied an opportunity for further investigation of the subject, each year bringing more definite knowledge of the morbid processes affecting the right iliac fossa. So long as disease of the vermiform appendix was seen only on the autopsy table when the disease had had time to extend to adjacent parts, it was natural that the primary lesion should appear to be situated in the cæcum or some other part of the intestine more important in their eyes

than the appendix. As soon, however, as coeliotomies with removal of the appendix began to be performed, it became increasingly plain that the morbid process began in the appendix itself, and as opportunities for investigation multiplied, the importance of this little organ as the cause of illness and death became each year more apparent.

The first operation on the appendix performed in the United States was done by R. J. HALL, of New York, on May 8, 1886 (*New York Med. Jour.*, 1886, vol. 43, p. 662). The patient was a boy of seventeen who had had an irreducible hernia for several years. About two weeks before he was seen he began to suffer from complete obstipation, and three days before the hernia became irreducible. After that he had vomited continuously and was apparently in collapse when brought to the Roosevelt Hospital. There was pain and tenderness over the whole abdomen, which was somewhat retracted, and the hernial sac was swollen, red, and intensely painful. In the right inguinal and scrotal region there was a pear-shaped swelling about eight inches long, the skin over which was congested and semi-fluctuant. A diagnosis of probable strangulated hernia was made and operation performed at once. The incision, which was about three-quarters of an inch long, extended down to the back of the hernial sac, and when it was opened, about a pint of fetid sero-pus escaped. Behind the sac lay the swollen and œdematous spermatic cord, and just outside the external ring, on the posterior wall was a solid mass covered with a greenish diphtheritic exudate. The tunica vaginalis was distended with fluid, and at the most dependent part of the scrotum was what seemed to be the normal testicle. Closer inspection showed this to be the vermiform appendix, curled up upon itself, and much thickened at its cæcal attachment. Near its base was a small oval perforation. The appendix was ligated above this opening with catgut, freed from attachments, and then removed. The stump was disinfected with a strong bichloride solution (1:1000) but not sutured. The incision was prolonged upward about three inches so as to admit the hand and forearm and explore the abdominal cavity. Some fresh abdominal adhesions were broken up, a number of pus cavities emptied, and a large amount of sero-pus scooped out of the true pelvis. The patient's condition at the end of the operation was bad, but he began to improve at once and made an excellent recovery. Hall remarks, "in a somewhat hasty search I have been unable to find any case of perforative peritonitis due to ulceration of the vermiform appendix successfully treated by laparotomy and resection of the appendix." This claim, if the qualifications are borne in mind, is correct, for Krönlein's case did not recover, and in Symonds' case there was no laparotomy. Hall's operation, however, was undertaken for the relief of a strangulated hernia and the lesion of the appendix was discovered incidentally.

The first successful laparotomy followed by removal of the appendix, undertaken with that possibility in view, was done by THOMAS G. MORRIS, of Philadelphia, on April 27, 1887 (*Trans. Coll. Phys. Phil.*, 1887). The patient was a man of twenty-six, who had been subject to attacks of

abdominal pain for some years. On April 20, 1887, he consulted Dr. FRANK WOODBURY for an attack of the usual kind by which he was much prostrated. During the next few days the pain grew worse and was accompanied by nausea and vomiting with some relaxation of the bowels. Examination showed the point of greatest tenderness to be between the umbilicus and Poupart's ligament, where a resistant mass could be made out. On April 27, 1887, a diagnosis of "either intussusception or perityphlitic abscess" was made by Dr. WOODBURY, in which Dr. MORTON, who was called in consultation as to the question of operation, concurred. By Dr. MORTON's advice, operation was immediately performed by him, assisted by Dr. WOODBURY and Dr. J. C. WILSON. An incision was made directly over the swelling, and, as the deep muscles proved to be infiltrated with pus, it was lengthened until it was ten inches in length. When the peritoneum was opened, a free flow of pus, having a fecal odor, escaped from an abscess cavity in which lay a fecal concretion the size of a cherry-stone. The appendix was greatly swollen and a perforating ulcer extended around its circumference. A silk ligature was tied close to the cæcum and another at the terminal portion of the appendix; the intervening portion, which constituted the greater part of the organ, was then removed together with a large piece of omentum which projected into the abscess cavity. The cavity was then curetted and douched with hot water at 110° F., the peritoneum was washed out until it was free of pus, and a drainage tube carried into the inmost part of the pelvic basin. The patient began to improve at once and made a rapid recovery. I have abstracted this report from the original publication, supplementing it with some details furnished me by Dr. WOODBURY, from whom I learned that the patient was living and engaged in successful business eighteen years later.

Dr. MORTON had for a long time been interested in the surgery of the appendix. He had himself lost first a brother and then a son from disease in it, and in both cases he had urged operation without being able to convince the surgeons in charge of its desirability. His attention having been thus focussed upon the subject, he gave it much thought, often speaking to his friends and his students upon the possibilities for good in early coeliotomy when there were symptoms of disease in the right iliac fossa, and inculcating upon his students the duty of pursuing this course of treatment. He was determined, he said, to operate himself upon the first suitable case which came into his hands, and the one just described gave him the looked-for opportunity. Dr. MORTON was, I believe, the first person to trace the evolution of those cases, with which we are now so familiar, where a foreign body (fecal concretion) causes a chronic appendicitis that remains unsuspected until some external cause, such as a blow, sets up an acute inflammation. In 1889 he reported a case (*Phil. Med. and Surg. Reporter*, 1889, vol. 61, p. 654) where he made a diagnosis of acute appendicitis excited by a blow in the right iliac fossa, the remote cause being chronic inflammation associated with a foreign body, a diagnosis which was confirmed by operation.

On December 30, 1887, an operation was performed by HENRY B. SANDS, of New York (*New York Med. Jour.*, Feb., 1888, vol. 47, p. 197), which deserves special attention, because it is the first occasion on which an unhesitating diagnosis was made before performing cœliotomy for disease of the appendix. The patient was a young man who had been ill for some time with pain in the lower abdomen accompanied at first by vomiting. There was exquisite tenderness over the right iliac fossa as well as tympanites, but no tumor. Dr. SANDS made a positive diagnosis of "acute septic peritonitis caused by perforation of the vermiform appendix" and advised immediate operation. Accordingly, forty-eight hours after the onset of the attack, he made a vertical incision four inches long, beginning at a point half an inch above the middle of Poupart's ligament and ending about the same distance below the level of the umbilicus, which was afterwards lengthened three-fourths of an inch below. The appendix was found perforated and a fecal concretion lay in the opening with another in the peritoneum below the cæcum. The margins of the perforation were slightly trimmed with scissors and brought together with three silk sutures, after which the diseased parts were irrigated with warm water and syringed with half a pint of a solution of warm bichloride of mercury (1 : 1000). The upper part of the abdominal wound was closed and the lower part left open and packed with iodoform gauze. The patient made an excellent recovery.

I have described these four cases in detail, because they are among the earliest on record and also because each one of them illustrates some special feature in the history of the surgery of the appendix. Krönlein's case is the first in which a cœliotomy was performed and the appendix removed; the diagnosis, however, was an alternative one and the operation was not successful. Symonds' case is the first done for an appendicitis during the interval, and was undertaken upon a positive diagnosis, but the abdomen was not opened, and the appendix was not removed. Hall's case was the first cœliotomy and removal of the appendix in the United States, and the first such operation followed by recovery, but the diagnosis did not include the appendix at all. Morton's was the first successful cœliotomy and removal of the appendix undertaken with the appendix in view; the diagnosis, however, like that of Krönlein, was alternative. Sands's was the first successful cœliotomy for disease of the appendix undertaken upon a positive diagnosis of appendicitis.

After this date operations for the removal of the appendix multiplied with great rapidity. I wish that it were possible for me to cite in detail all the early cases on record and discuss the lessons drawn from them by the pioneers in this line of work; unfortunately, space forbids my doing so, and I must content myself with mentioning with the utmost brevity the cases that have come to my notice exclusive of those already mentioned up to the year 1890, after which they became comparatively common and ceased to excite interest except under unusual circumstances. These cases have been arranged in order of publication, and when the month in which the report appeared could not be ascertained it is placed at the end of the list for the year. (See end of chapter.)

It is greatly to be regretted that some of the men who have done most to develop the surgery of the appendix did not publish their first operations upon the appendix at the time they were performed, nor even, in some instances, preserve any record of them at all. The further evolution of the surgery of the appendix consists in the development of its technic from the crude simple ligation and amputation of the appendix, which is all we find in the earliest operations, to the highly specialized and often purely individual procedures now in use. One of the first steps in advance was the sterilization of the stump of the appendix; then its protection by means of a little cuff of peritoneum drawn over it for the purpose; next it was ligated and depressed into the cæcum while the adjacent surfaces of the cæcum were drawn over it and stitched together; then came the inversion of the stump, or even of the entire unopened appendix (Edebohls); and finally we find the cautery, or the cautery clamp, employed to sterilize and seal the stump before burying it in the cæcum.

A number of different incisions have also been devised and employed, — that of Sonnenburg, Fowler, McBurney, Battle (also Lennander and Jalaguier), Morris, and Edebohls. Most of these methods, whether for incision or removal, have their advantages and their special fields of usefulness. The best results are probably obtained by the man who does not adhere rigidly to any one of them, but makes all subservient to his ends according to the requirements of the individual case.

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CHAPTER II.

ANATOMY OF THE VERMIFORM APPENDIX.

Embryology.—At the end of the first month of intra-uterine life the intestinal canal is in the form of a small loop protruding into the umbilical cord. ×

The cæcum is visible during the fifth fetal week as a slight elevation a short distance from the most anterior portion of the loop (Fig. 1). ×

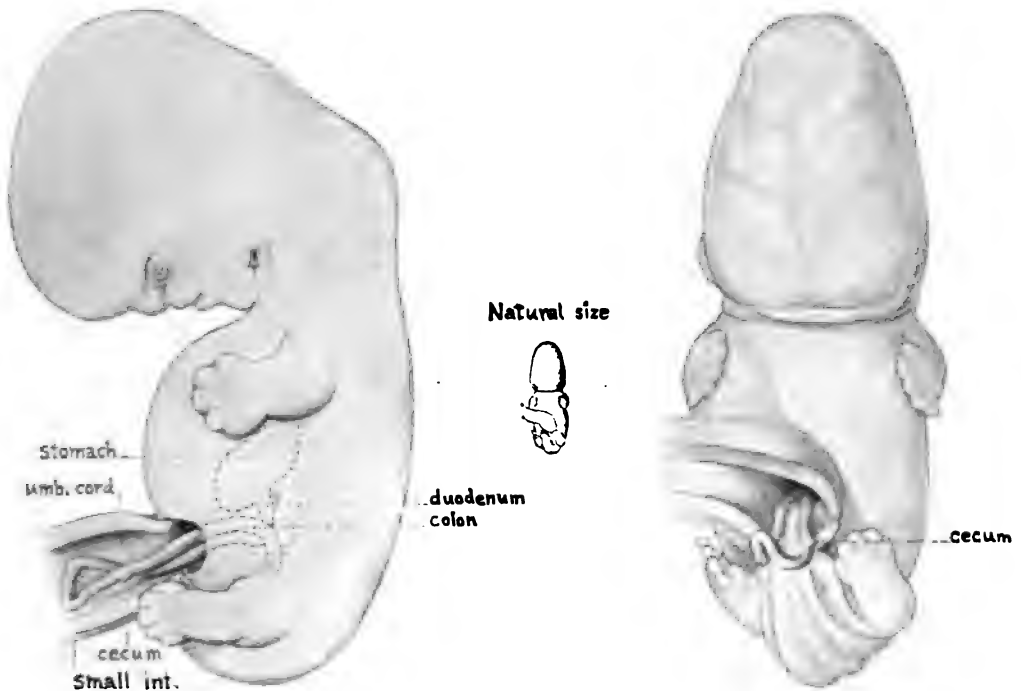


FIG. 1.—HUMAN EMBRYO. SIX WEEKS. MAG. 5½. (MALL.)

This figure represents the lateral and anterior aspects of the same embryo with the umbilical cord cut open to show the loop of intestine protruding into it. The loop is composed of two limbs: (1) the cranial, coming from the stomach, and (2) the caudal, descending toward the cloaca. At the point where they leave and enter the body, the caudal limb lies slightly above and to the left of the cranial. This condition is more plainly seen in the left diagram. The small budding cæcum may be seen on the lateral side of the caudal limb at about one-third the distance from its most anterior point. Its position marks the division between small and large intestines.

Between the sixth and seventh weeks the small intestine increases in length, forming a number of loops and contortions, which lie within the cord, to the right, partly in front of and partly below and behind the budding cæcum (Fig. 2).

Between the seventh and eighth weeks a minute process is almost invariably found at the tip of the cæcum (Fig. 2). At about the eighth

week this bud is seen to become thinner, and, finally, to disappear, while the cæcum continues to grow, the end still maintaining its blunt shape.

This structure, which makes its appearance at the tip of the cæcum and vanishes later on, may be a transient vermiform appendix, similar to

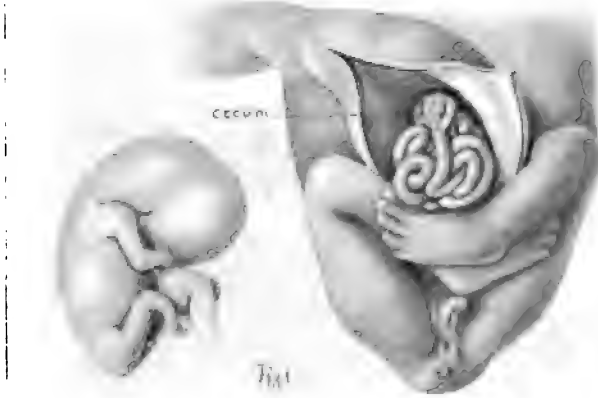


FIG. 2.—HUMAN EMBRYO. SEVEN AND A HALF WEEKS. 25 MM. CERVICO-COCYGEAL MEASURE. (MALL, No. 89.)

The small intestine has increased rapidly in length, forming a large mass of convolutions which in greater part lie within the cord. The large intestine lies almost entirely concealed within the body, but the elongated cæcum, with its minute projection at the tip, may be seen near the junction of the cord and the body, lying cranial to the rest of the intestine.

other transient structures which are formed during embryonic life, or it may represent a stage in the life-history of the human cæcum, which at one time more nearly resembled that of certain monkeys; as, for example, the Mangabey monkey or the gibbon.

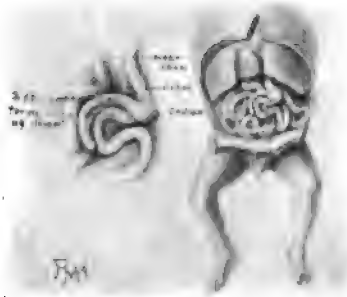


FIG. 3.—HUMAN EMBRYO. TEN WEEKS. 7.5 CM. (BRÖDEL, No. 18.)

The cæcum and appendix lie near the middle line, just beneath the liver. The differentiation between them is well marked.

Toward the end of the seventh week the intestines begin to recede into the body, their entrance being accomplished between the eighth and ninth weeks. The cæcum then lies near the umbilicus, and the entire large intestine lies wholly to the left of the median line. The rotation of the intestine continues, and the colon, with the cæcum and appendix, is pushed upward in front of the duodenum until they lie just beneath the liver and near the middle line (Fig. 3).

The large intestine still maintains the integrity of the mesentery and can be moved around freely within certain limits, there being no fusion whatever with any portion of the posterior abdominal wall. Between the ages of three and four months the cæcum occupies the subhepatic position, immediately anterior

to the right kidney. The cæcal pouch now points downward and the ileum enters from the left (Fig. 4).

If not retarded by adhesions, the cæcum may arrive in the iliac fossa as early as the fourth month, but it is usually later than this date (Fig. 5).

The position and form of the adult cæcum and appendix depend largely upon the time during their development at which they come into contact with the posterior abdominal wall. If coils of intestine remain interposed between them during the descent of the ileocæcal portion it may reach the right iliac fossa without having contracted any adhesions. This gives a comparatively free cæcum and pendent appendix. If, however, the coils of ileum are early displaced, and the cæcum and appendix come into early contact with the posterior abdominal wall, the posterior surface of the cæcum is apt to fuse at a comparatively high level with the abdominal wall, and any further descent is, as a rule, accompanied by a sagging down of the anterior cæcal wall and a rotation of the cæcum to the left. The appendix, if not individually adherent, follows this movement. The appendico-cæcal junction becomes shifted during this rotation in an upward and posterior direction, the appendix itself pointing in varying ways, upward, downward, outward, or toward the spleen, according to the length of its mesentery.

DIFFERENTIATION BETWEEN APPENDIX AND CÆCUM.—The embryology of the appendix teaches us that it does not maintain the degree of development it reached in the foetus.

From the fifth week up to the seventh week the cæcum is of the same width as the rest of the intestine.

The *primary* differentiation into a proximal pouch and smaller distal portion begins generally between seven and eight weeks. We first begin to observe a decrease in thickness of the distal portion of the cæcum as compared with the rest of the intestine. From the age of three months up to six months the differentiation between the cæcal pouch and its narrowing distal extremity, the appendix, becomes more and more pronounced, and at the sixth month it is only about one-third the width of the large intestine.

About the time of birth a *secondary* differentiation of the appendix from the cæcum takes place, producing changes in the latter which give rise to the characteristic sacculatation of the large intestine in general,



FIG. 4.—HUMAN EMBRYO. THREE MONTHS.
(BRÖDEL, No. 10.)

The greater portion of the small intestine has been removed, leaving the mesenteric ruffle to indicate its position. The cæcum and appendix have advanced to a position in front of the right kidney, the iliac coils in the renal region having swung over to the left, allowing this juxtaposition. The large intestine and its mesentery have not contracted any adhesions so far, and, owing to the beginning downward movement of the cæcum, there is now an ascending colon proper. The appendix is almost entirely hidden behind the termination of the ileum and its mesentery, the relation of the ileum, cæcum, and appendix to each other being similar to that in the adult, except for their high position. The small diagram at the left is a posterior view of the ileocæcal region, somewhat magnified.

and of the cæcum especially. The walls of the cæcum and colon are subjected to a pressure from within which causes the longitudinal muscular coat to separate into three bundles, between which the inner coats bulge out in pouches, producing, in a sense, hernial protrusions covered by circular muscle. The separation of the longitudinal muscle does not involve



FIG. 5.—HUMAN FÆTUS. SIX TO SEVEN MONTHS. ♂. NATURAL SIZE. (BRÖDEL. VI.)

The ileum has been for the most part removed, exposing the large intestine, which is very much convoluted owing to the relative shortness between liver and pelvis. The transverse colon is in part covered by the growing omentum. At the left of the picture lie the cæcum and appendix, which have not yet completed their descent into the right iliac fossa. The cæcum and beginning portion of the colon are free from adhesions along their posterior surfaces, but the posterior fourth of the appendix is bound down by adhesions which pass from it over the spermatic vessels and become lost on the posterior parietal peritoneum. The remainder of the appendix is free and lies curled beneath the cæcum.

the appendix, and so we find the three bands converging toward the root of the appendix, in order to become continuous with its longitudinal muscular coat.

Between the distention of the cæcum in the newborn and adult there is noticeable a steady increase, and if we compare the width of the appendix with that of the cæcum in the different ages concerned, we find that it amounts in the newborn to one-third to one-fourth the cæcal diameter, while in the eight-months-old child it is one-fourth to one-fifth; at eight years it is one-sixth to one-seventh; and in the adult, about one-eighth.

Comparative Anatomy.—From the stand-point of comparative anatomy the appendix vermiformis should be regarded as an undeveloped cæcum. If the appendix in the human subject were expanded to the size of the caput coli, the whole diverticulum would closely resemble the cæcum of many mammalia.

The entire alimentary canal, and especially the ileocolic region, of all vertebrates is found to respond with great readiness in its structure to variations in functional demand.



FIG. 6.—THE FOLDS AND FOSSÆ OF THE ILEOCÆCAL REGION.

The cæcum is lifted up out of its bed in the iliac fossa, exposing the retrocæcal folds and fossæ. The appendix has been drawn out of the ileocecal fossa to show the mesappendix.

The appendico-cæcal pouch increases the extent of the intestinal mucous surface for secretion and absorption, and prolongs the period during which the contents of the canal are retained for digestion and absorption. It acts as a reservoir in which partly digested substances, mixed with the secretion of the small intestine, are retained for a shorter or longer time in order that the process of absorption may be completed. The cæcum acts, therefore, as a second stomach for the purpose of holding the food longer, and thus extracting from it a fuller amount of nutriment.

There is a definite relationship between the length of the cæcum and that of the large intestine, a long end-intestine corresponding to a long cæcum, and vice versa.

Almost all mammalia are provided with a cæcum. The size bears an important relation to the kind of nourishment; meat-eating or carnivorous animals possess a small and simple cæcum or none at all, while in herbivorous animals it is large and may even exceed the length of the body. Among those animals which have a mixed diet, such as many rodents, the wombat, apes, and man, a part of the cæcum undergoes a more or less marked retrogressive change, so that it remains as a thin, worm-like process attached to the otherwise well-developed cæcal pouch.

The arrangement of the stomach also influences the size of the cæcum. In single-hoofed animals with a single stomach, the cæcum is better developed than in split-hoofed animals, which chew their food twice, and which are provided with more than one stomach.

Folds and Fossæ.—The folds and fossæ about the ileocæcal region have been divided into the pericæcal and the retrocæcal or subcæcal. The *pericæcal folds* lie above and to the left of the cæcum and include the ileocolic and ileocæcal folds and the mesappendix (Fig. 6), and are, with a very few exceptions, constant. By retrocæcal or subcæcal folds and fossæ we understand those situated behind and beneath the cæcum. While the former are at once visible, the latter cannot be seen without lifting up the cæcum.

The *ileocolic fold* (Fig. 6) lies in the angle between the ileum and the colon. It is semilunar in shape, its free or concave margin being turned toward the ileum. Along its free or inner margin the anterior ileocolic artery passes with its accompanying vein, also several lymphatic channels. Frequently it contains one or more lymphatic glands embedded between its two peritoneal layers, also a varying amount of fat.

The ileocolic fold covers the ileocolic fossa, which varies in depth from a very shallow or scarcely distinguishable pocket to one deep enough to admit the thumb beyond the nail. The floor of this fossa is formed by the ileum and colon at their junction, and by their mesentery.

The *ileocæcal fold* occupies the ileocæcal angle (Fig. 6) and lies anterior to the mesappendix. Its superior border is attached to the lower edge of the ileum for a distance of from 5 to 10 cm. Its right or external border lies along the cæcum; its inferior border becomes lost on the anterior surface of the mesappendix, while the internal border is free and concave and forms the entrance to the ileocæcal fossa, which varies in depth and size according to the size of the fold. Sometimes it is very slight—a mere chink; at other times the fossa is deep enough to admit several fingers for a considerable distance, or even large enough to lodge a small apple.

The *mesappendix*, when normally situated, lies partly or nearly concealed by the ileum and its mesentery, which frequently cover also a portion of the appendix as well.

The mesappendix arises above from the under layer of the mesentery of the ileum. Its right or external border is inserted along the posterior internal face of the cæcum, its inferior margin corresponds to the border of the appendix, while its left or internal border is free. Upon the length of this free border depends, in great measure, the position of the appendix: if long, the appendix appears straight or slightly curved; while if too short, the appendix is drawn into a spiral or a number of varying bends.

The free border of the mesappendix envelops the main appendical artery, with its accompanying vein, lymphatics, and nerve. Secondary branches pass from these to the appendix, between the two peritoneal leaves of the mesentery.

The mesappendix in normal cases goes all the way to the tip, or may even extend slightly beyond it, forming a knob-like projection; it, however, frequently appears to stop at some distance from the tip, extending, in some cases, according to Treves, Jonesco, and others, only to the middle of the appendix, or to the junction of the middle and distal thirds.

The *retrocæcal or subcæcal folds and fossæ* depend entirely for their existence upon the coalescence or adhesion of the colon, cæcum, and mesentery to the posterior abdominal wall, and are therefore secondary in origin as compared with the three folds previously described. In some cases the cæcum never becomes adherent to the posterior abdominal wall, and we therefore find no retrocæcal folds or fossæ.

The large intestine at the time of fusion represents a straight tube, to which the cæcum is attached in the form of a simple round pouch. The lateral and inferior line of fusion when complete is, therefore, a comparatively unbroken one, until the cæcum and colon begin to balloon out to form the characteristic pouches so pronounced in the adult. This uneven expansion lifts up the peritoneum in a series of folds which have been observed in great variation and described by many authors. If the fusion was originally incomplete, the fossæ are deep; while in cases of complete fusion the fossæ are comparatively shallow.

The most capacious and the most constant of the fossæ is the internal retrocolic (Fig. 6), also called inferior ileocæcal, which can only be demonstrated by lifting up the cæcum, appendix, and ileum. It is then seen as a funnel-shaped pocket extending in an upward direction under the ileum and colon. From the depth of this fossa arises the posterior leaf of mesappendix, and the entire appendix is oftentimes found curled up in this space, while its tip may point in various directions.

The Reflection of the Peritoneum.—While the anterior surface of the large intestine and its mesentery are covered by peritoneum, the posterior surface becomes fused with the peritoneum of the parietal abdominal wall. This process begins about the fourth month of intra-uterine life and proceeds from the centre to the periphery. It may be extensive, or it may be limited to a comparatively small area.

In studying the eight diagrams given in Fig. 7, a comprehensive view may be obtained of the types of peritoneal reflection in the ileocolic region.

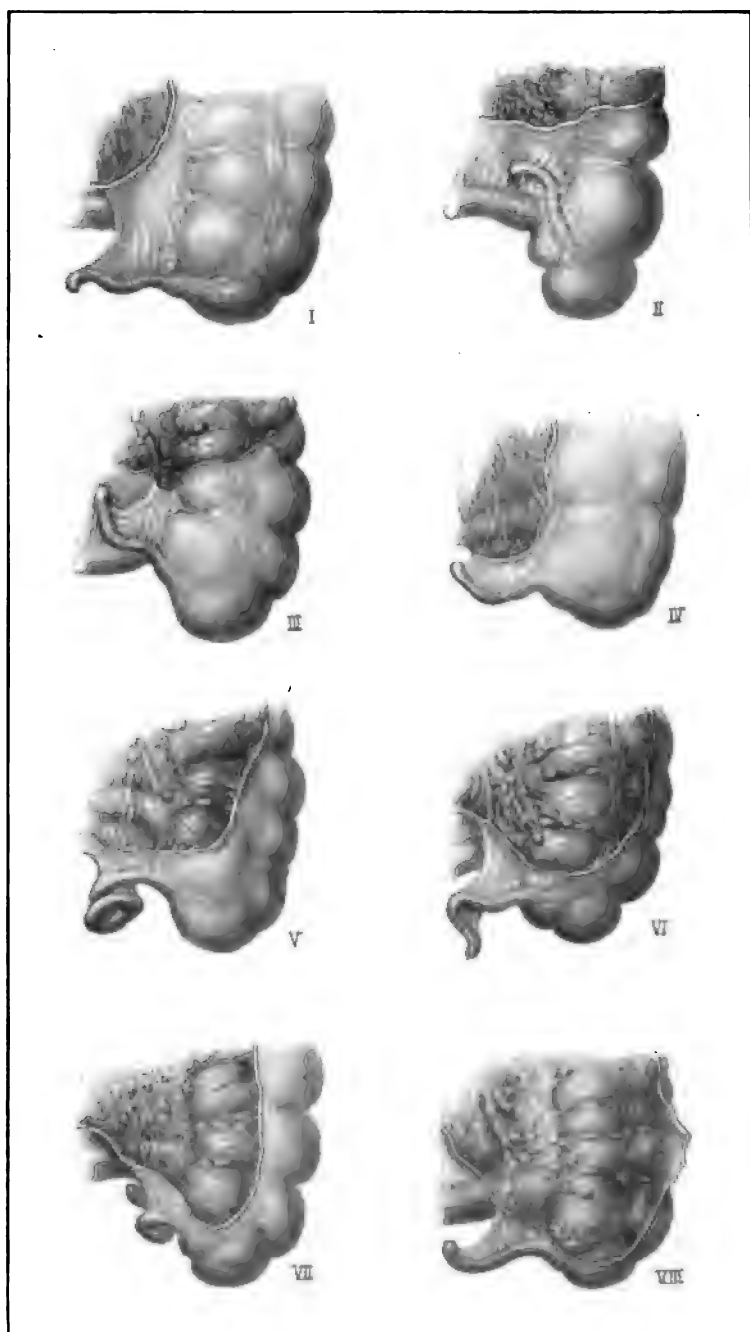


FIG. 7.—THE EIGHT MOST FREQUENT TYPES OF PERITONEAL REFLECTION OF THE ILEOCÆCAL REGION. The intestine is viewed from behind. The extraperitoneal surfaces are drawn darker in order to differentiate them from the smooth serous surfaces of the intraperitoneal portion.

Type I, 8%. II, 4%. III, 16%. IV, 10%. V, 8%. VI, 30%. VII, 16%. VIII, 8%.

The most frequent arrangement is shown in Type VI. The line of reflection runs somewhat obliquely from the posterior leaf of the mes-appendix, across the lower portion of the ascending colon, traversing the posterior muscular band at a point about 8 cm. from the cæcal pouch and continuing upward close to the lateral colic margin. The distance of this line from the lowest point of the cæcum may vary considerably, producing transition forms with the other types. The ileum is completely covered by peritoneum and the appendix frequently lies tucked away under it.

The question whether the appendix is an intraperitoneal or extraperitoneal organ is chiefly decided by the position it assumes in relation to the cæcum and colon.

Figs. 8, 9, and 10 show the most striking types of intraperitoneal and extraperitoneal appendices.

The Inner Surface of the Ileocæcal Region and Its Valves (Fig. 11).—The mucous membrane lining the colon and cæcum is arranged in folds, which, with the intestine in a state of contraction, are very numerous and describe a wavy course. Their main direction is transverse and the wavy appearance is due to the contracted circular muscle fibres. With the

intestine moderately distended, the great majority of these folds are smoothed out, leaving but a few of them as permanent transverse folds, the so-called semilunar plicæ of the colon. Between these the pouches of the large intestine are seen to balloon out to a varying extent.

The deepest plicæ consist of reduplications of all the coats of the intestine, the musculature and serosa, however, extending only halfway into the fold. The shallower plicæ are composed only of mucosa and submucosa.

In the embryo and foetus there are no plicæ except the frenulum of the ileocolic valve, running around the median half of the large intestine



FIG. 8.—The middle portion of the ascending colon is adherent to the parietal abdominal wall; the rest of the colon, cæcum, and the appendix are intraperitoneal.

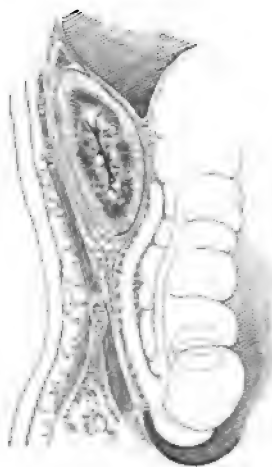


FIG. 9.—The appendix is adherent to the posterior surface of the colon as well as to the posterior abdominal wall, —i.e., it is of the extraperitoneal ascending type.

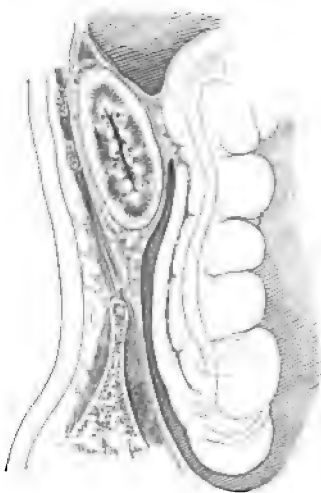


FIG. 10.—The appendix is adherent to the posterior wall of the colon, but not to the posterior abdominal wall. On turning the colon toward the middle of the body, the appendix is easily exposed to view.



FIG. 11.—THE VALVES OF THE ILEOCÆCAL REGION.

A portion of the anterior wall of the large intestine has been removed in order to show the structures in the interior. The large transverse plica dividing the cæcum from the colon, and called the frenulum, separates into two lips which form the ileocæcal valve. The upper of these lips slightly overhangs the lower. Below the valve we see the large expanded cavity of the cæcum. At the lower median portion of this lies the crescent-shaped appendico-cæcal valve. The two small diagrams are sections of the two valves, the upper right-hand picture demonstrating the construction of the ileocæcal valve, the lower left-hand picture that of the appendical valve.

and dividing the cæcum from the colon. Because this is first to form, it develops to greater size than the others, which do not make their appearance until after birth, when the sacculæ of the colon begin to bulge out. The frenulum is also produced by a different process than the other plicæ, in so far as it owes its formation to a projection of the terminal portion of the ileum into the lumen of the large intestine. The ileum thus lifts up a transverse fold, which becomes a valve at this junction.

Any pressure arising from within the cæcum or colon will serve to tighten this valve, and contraction or tension of the circular muscle fibres in the frenulum will have the same effect.

On opening the cæcal pouch from above and looking toward the appendical opening, the mucous folds are seen to be grouped more or less concentrically, the shortest being around the orifice of the appendix, where it may simulate a valve.

The most frequent arrangement is shown in Fig. 11, where a semilunar fold or reduplication of mucous membrane is seen just above the appendical orifice.

This structure is, however, not a valve in the true sense of the word, and is clearly seen only when the appendix comes off at an acute angle from the cæcum,—*i.e.*, if there is a sudden kink at the appendico-cæcal junction, the axis of the appendix running at an angle of less than 45 degrees to the wall of the cæcal pouch. This angle varies, according to the different positions of the appendix, from 20 degrees to 90 degrees. If the appendix has a short mesentery and ascends for some distance behind the ileocæcal junction, as is the case in the majority of instances, the smallest angles are produced. A distention of the cæcum will then cause the semilunar fold to lay itself over the opening of the appendix and thus act as a valve.

An appendix having a wide mesentery and directed toward the iliac vessels usually forms an angle of 40 degrees to 60 degrees with the cæcal surface. In such cases the semilunar mucous folds frequently do not suffice to close the orifice, and a distention of the cæcum will involve the appendix.

Position of the Appendix.—The location of the point of origin depends entirely upon the topography of the cæcum. According to whether the cæcal pouch is directed upward or downward, outward or inward, forward or backward, or whether colon and cæcum have rotated insufficiently or too much around their long axis, the point of origin of the appendix varies in position. It may be found at almost any point of the cæcal pouch, as shown in Fig. 12.



FIG. 12.—DIAGRAM SHOWING THE VARIOUS PLACES ON THE SURFACE OF THE CÆCUM FROM WHICH THE APPENDIX MAY TAKE ITS ORIGIN.

The changes in position of the origin are brought about by the varying topography of the cæcum.

The point of origin of the appendix on the cæcum has considerable influence on pathological conditions. In connection with this we may distinguish the two main positions, the retrocæcal and the precæcal. While the latter would mean danger to the patient in case of disease of the appendix, the former would signify comparative safety.

The direction and course which the appendix takes are regulated by its length and consistency, and by the mobility given to it by its mesentery. The tip may point in almost any direction. Fig. 13 pictures more in detail the various directions in which an appendix may point.

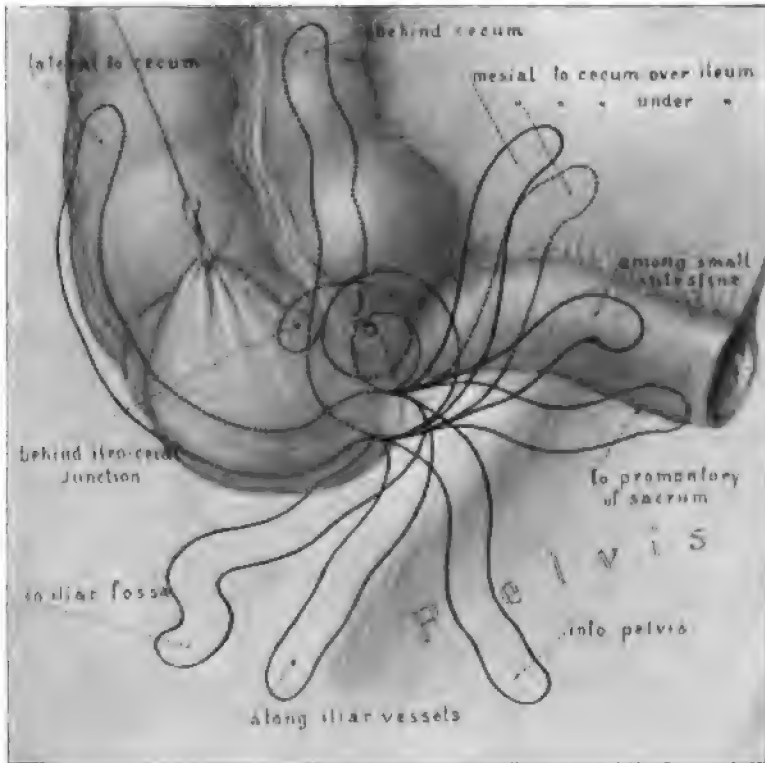


FIG. 13.—DIAGRAM SHOWING THE VARIOUS DIRECTIONS IN WHICH AN APPENDIX MAY POINT.

The normal position of the ileocæcal apparatus is in the right iliac fossa, the cæcum occupying the triangular space between the iliac vessels and Poupart's ligament (Fig. 14).

Fig. 15 shows the main variations of cæcal topography inside the right lower quadrant of the abdominal cavity.

Abnormal positions of the appendix are caused by an abnormally long mesentery and by arrested foetal development. A long mesocolon may permit a complete shifting of the large intestine to the left side of

the body. The excursions of such a movable ileocæcal apparatus make it possible for the appendix to be located in inguinal, femoral, and umbilical herniæ.

Dimensions of the Appendix.—The average length of the appendix is about 8.3 cm., or between 3 and 3½ inches. Extremely short appendices have been described: by Bryant, 6 mm.; Huntington, 5 mm.; and H. T. Marshall, 2 mm. Authentic cases of complete absence of the appendix have been described by Zuckerkandl, Bryant, and Huntington.

From the minimum of 2 mm. appendices range in length up to 24 cm. (9½ inches) or more. The longest appendix on record, to our knowledge,

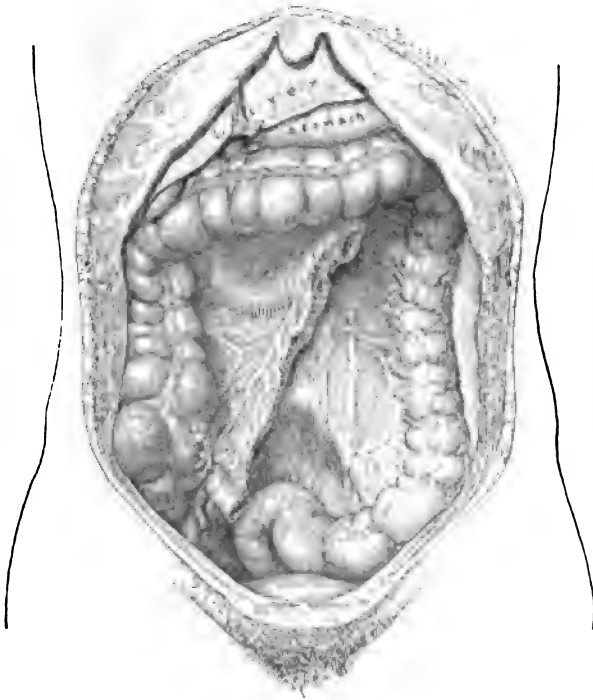


FIG. 14.—THE NORMAL POSITION OF THE ILEOCÆCAL APPARATUS.
The appendix is usually not visible until the cæcum is lifted out of the iliac fossa.

is one presented by F. Grauer, of New York, to the Northwestern Medical and Surgical Society in 1890. It measured 12¾ inches in length (33 cm.).

The width of the appendix varies from 3 to 8 mm. or more, with 6 mm. as the normal.

The diameter of the lumen changes according to the contents of the canal. It amounts to from 1 to 3 mm. or more.

The Structure of the Appendix.—The different coats, beginning with the outside, are: (1) peritoneal or serous coat; (2) longitudinal muscular coat; (3) circular muscular coat; (4) submucosa; (5) mucosa.

The thickness of the coats of the appendix varies from 1 to $2\frac{1}{2}$ mm. Of this the peritoneal and muscular coats compose about one-third, the rest being submucosa and mucosa (Fig. 16).

The transparent serous coat with its peritoneal surface is about 0.1 mm. in thickness and is closely attached to the appendix, rendering its surface smooth and glistening. It consists of a simple layer of flat, polygonal endothelial cells, resting upon a delicate subperitoneal layer, which is made up of loose fibres and elastic tissue, and connects the peritoneum with the underlying structures. This subperitoneal tissue bears within its meshes a variable amount of fat and contains the superficial blood-vessels, lymphatics, and nerves.

The thickness of the longitudinal muscular coat of the appendix varies in different individuals and also in the same specimen from 0.2 to 0.3 mm.

The circular muscular coat measures from 0.2 to 0.5 mm. in width. Both muscular coats are perforated at various points to permit of the entrance and exit of the nerves, blood-vessels, and lymphatics. Such a perforation is called a muscular hiatus, and they are found in varying numbers along the mesenteric border of the appendix. The last hiatus is generally found at the tip and is considered by some writers as the cause of the weakness of the appendix at this point.

The muscular layers are composed of smooth muscle fibres. Their spindle-shaped protoplasm is of considerable length as compared

with their small, elongated nucleus. A section of muscle parallel to the fibres will, therefore, show more nuclei than a section taken at right angles, where many of the fibres would be cut to either side of the nucleus (Fig. 16).

The thickness of the submucosa varies greatly in different individuals (0.2 to 0.8 mm. or more). It is this layer which gains most in thickness during the process of obliteration.

The submucosa consists of loose, wavy strands of fibrous and elastic tissue which forms a framework for the blood- and lymph-vessels and nerves. In the interspaces are fat globules.

The mucosa is bound to the submucosa by the vestiges of a muscularis mucosæ.

The mucosa presents an irregularly folded appearance, the folds running parallel with the longitudinal axis of the appendix. Its surface, while

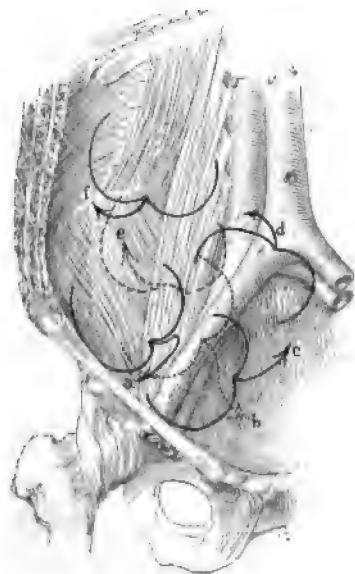


FIG. 15.—DIAGRAM SHOWING THE POSITIONS OF MODERATE DISPLACEMENT OF THE APPENDIX,—VIZ., IT IS STILL FOUND IN THE RIGHT LOWER QUADRANT OF THE ABDOMINAL CAVITY.

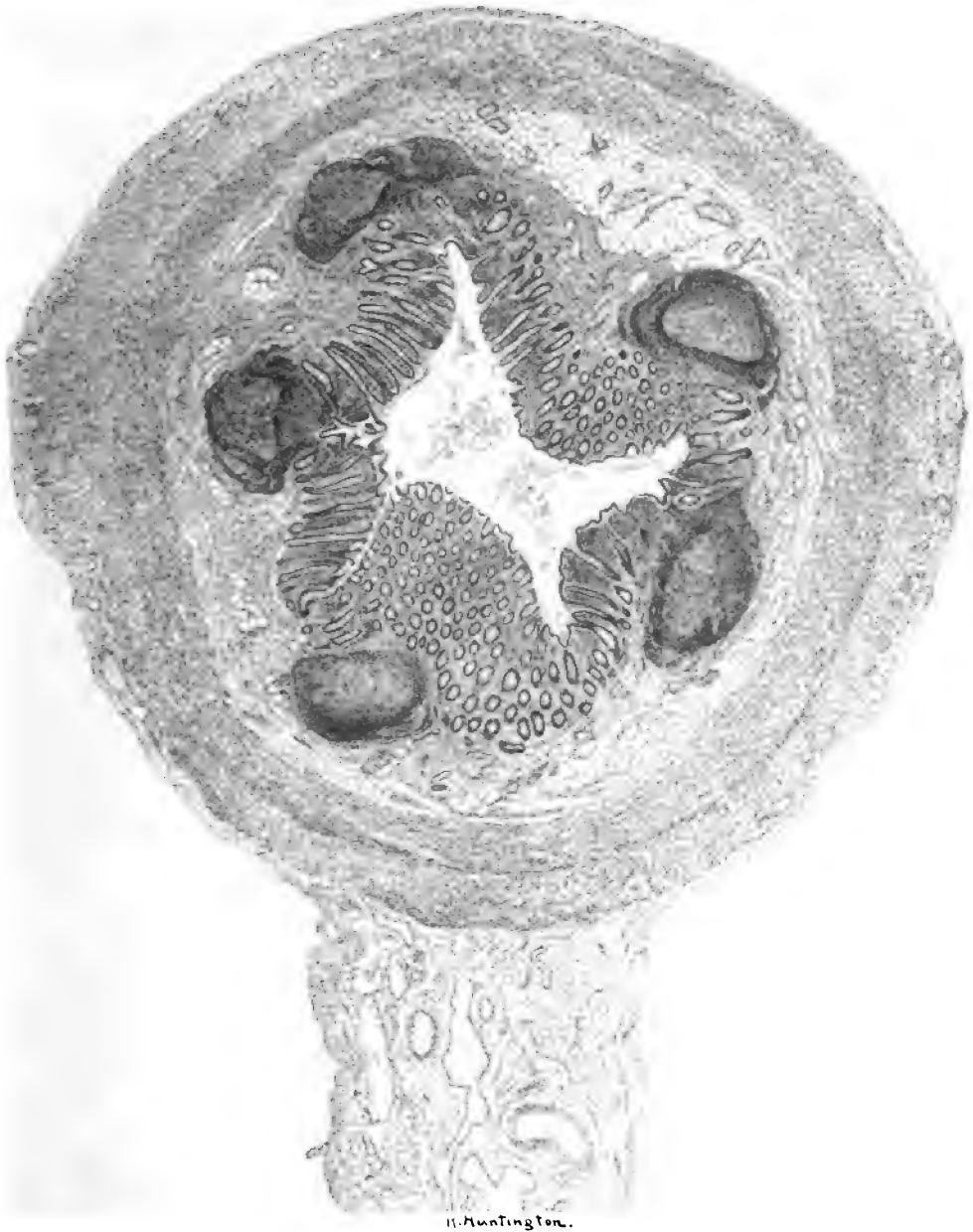


FIG. 16.—SECTION THROUGH A NORMAL APPENDIX, MAGNIFIED 25 TIMES.

The different layers, from without in, are: (1) The serous coat, consisting of a simple layer of flat endothelial cells, the serous, and the subserous tissue, containing the superficial vessels; (2) the longitudinal muscular coat whose bundles are seen in cross-section; (3) the circular muscular coat; (4) the submucosa, traversed by many vessels and supplied with a varying amount of fat; (5) the mucosa, consisting of a surface epithelium, dipping down into the glands of Lieberkühn, a tunica propria, situated between the glands, and a muscularis mucosae (not distinguishable), situated between the mucosa and the submucosa. Between the crypts of Lieberkühn and the submucosa, extending partly into the latter, are seen five lymph follicles. In this particular section they do not reach the surface. Their germinal centre stains more faintly than the periphery. The lumen of the appendix contains mucus, disintegrating cells, and fecal matter. At the lower portion of the section is seen the meso-appendix with its vessels. The spaces between the vessels are occupied by connective tissue containing a considerable amount of fat.

glistening to some extent, has a velvety appearance, due to innumerable delicate glandular openings, the glands of Lieberkühn.

These openings of the crypts of Lieberkühn are arranged around certain centres marked by slight depressions on the surface, which correspond to the apices of the lymph follicles (Fig. 17).

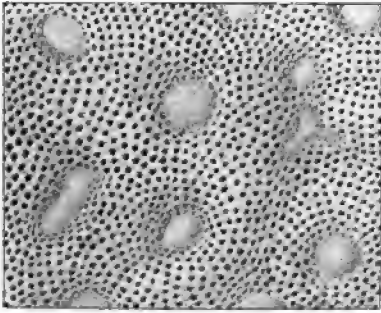


FIG. 17.—THE SURFACE OF THE MUCOUS MEMBRANE MAGNIFIED 6.5 TIMES.

The exposed portion of the follicles is visible as a dome-like elevation in a slight depression in the mucosa. Their size as well as their outline is variable, especially when two are seen to fuse. The surface of the mucosa between these nodes is studded with minute openings, the crypts or glands of Lieberkühn. Their arrangement is in rings around the lymph nodes and in rows radiating from the centre of the follicle.

The mucous membrane consists of an epithelium, a tunica propria, and the muscularis mucosæ. The epithelium dips down into a great number of simple tubular glands, the crypts of Lieberkühn, between which lies the tunica propria (Fig. 18). They rarely show dichotomous branching. The epithelium consists of a layer of columnar cells, which contain a granular protoplasm, numerous fat particles, and usually an oval nucleus and a cell membrane. Many of these cells show the common goblet form. There is also a homogeneous basal border characteristic of the intestinal epithelium. The regeneration of the epithelium, taking place by mitosis in the glands of Lieberkühn, causes the cells to move gradually upward to replace the disintegrating cells on the surface, though mitosis is also

known to take place in the latter. The youngest generation of epithelial cells is, therefore, as a rule, found in the glands, while the oldest generation is found on the surface. In obliteration of the appendix the mucous membrane disappears gradually, being shallowest in the corner of the obliterating angle.

The lymph nodes develop in the tunica propria immediately under the epithelium, and lie with their base against the muscularis mucosæ. The nodes are composed of lymphoid tissue usually containing a germinal centre.

The Arteries of the Appendix.—The vascular supply of the ileocæcal region comes from the ileocolic artery, the lower division of the right colic branch, which in turn is derived from the superior mesenteric artery.

The ileocolic artery divides into the anterior and posterior ileocæcal arteries, the appendical artery or arteries, an ascending colic branch, and one or more branches to the ileum (Fig. 23).

The origin and number of arteries to the appendix vary considerably. (See Types I, II, III, and IV, Figs. 19-22). In over one-third of the cases studied the main appendical artery supplied the entire appendix (Type I), and sometimes a little of the adjoining portion of the cæcum (Type III). In the remainder of the cases it supplied the distal four-fifths of the organ, while a second or even a third appendical artery

supplied the remaining proximal portion and anastomosed with the cæcal branches.

The main appendical artery gives off, on an average, five secondary branches. Having reached the hilum of the appendix, each branch of the



FIG. 18.—PORTION OF THE NORMAL MUCOUS MEMBRANE OF AN APPENDIX, MAGNIFIED 150 TIMES.

Above is the lumen of the appendix, into which are seen to open the crypts of Lieberkühn, some of which are cut obliquely, others transversely. The epithelium of the lumen and crypts is identical and consists of a single layer of columnar cells. Between the crypts or glands of Lieberkühn is the tunica propria, consisting of connective tissue, with small round cells and a few plasma cells. The lower half of the picture is chiefly occupied by a lymph node, which above is continuous with the tunica propria. The lymph follicle has a deeply staining layer of lymphoid cells in its periphery, while the germinal centre is composed of more faintly staining cells. Below the lymph nodes is a small strip of submucosa with fat globules and vessels, and beneath this are a few bundles of the circular muscular coat.

appendical artery subdivides into two or more sub-branches before penetrating the coats. These branches form two main systems within the coats,—the superficial in the serous coat, and the deep in the submucosa (Fig. 24).

From this submucous network a few branches are sent outward into the muscular layers, but the majority of its branches go toward the mucous coat. They ramify around the follicles and at the base of the glands, supplying each with numerous fine branches.

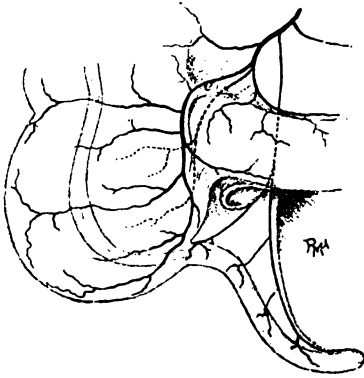


FIG. 19.—Type I. One artery, supplying only the appendix. Origin: ileocolic, or posterior ileocaecal, or anterior ileocaecal, or mesenteric branch of ileocolic.

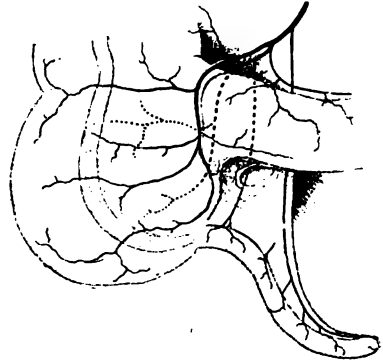


FIG. 20.—Type II. Two arteries, supplying only the appendix. Origin: ileocolic and posterior ileocaecal, or mesenteric branch and posterior ileocaecal.

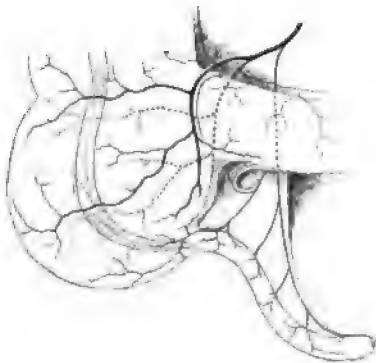


FIG. 21.—Type III. One or more arteries. Origin: ileocolic, posterior ileocaecal, mesenteric loop, etc. Proximal branch supplies a portion of the cæcum.

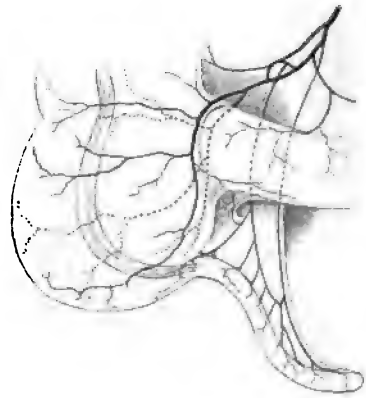


FIG. 22.—Type IV. Two arteries, forming a loop in the mesoappendix from which the individual branches arise.

The Veins.—Just beneath the mucous surface, between the glandular openings, the capillaries are seen to form a tortuous plexus which drains through short venous channels running parallel to one another and to the glands down into the venous network of the muscularis mucosæ.

The veins of the muscular coats drain partly into the submucous plexus, partly into the superficial plexus, the majority selecting the latter course. The direction of the small venules is parallel to the muscle bundles.

Throughout their entire course inside the appendix the veins in general lie central to the arteries.



FIG. 23.—THE BLOOD-VESSELS OF THE ILEOCÆCAL REGION.

Arteries red, veins blue. The peritoneal covering is removed so as to show the vessels more clearly. Above and to the right are seen the cut ends of the ileocolic artery and vein. This artery gives off a branch to the ascending colon and a posterior and anterior cæcal artery, the latter descending through the ileocolic fold. A short anastomosis connects the ileocolic with the mesenteric. The artery of the appendix is seen to arise from the posterior cæcal artery, 2 cm. above the ileum. It passes behind the ileum in the free border of the mesoappendix and gives off five branches (long appendices have 8-12, short appendices, 2-3), which traverse the mesoappendix at fairly regular intervals in the direction of the hilum of the appendix, where they divide into anterior and posterior branches. The branches in the mesoappendix are sometimes seen to anastomose, forming loops of varying size. The terminal branch curves around the tip. The cæco-appendical junction is supplied by a separate branch arising likewise from the posterior ileocæcal trunk. This branch may or may not anastomose with the proximal appendical twig, and while in some cases it supplies only the cæcum, in others, as in the present case, it sends a few delicate branches into the appendix. At the place where this cæco-appendical artery crosses the ileocæcal fold it is seen to give off a delicate recurrent twig to this structure. Throughout their entire course the arteries are accompanied by veins.

FIG. 24

FIG. 24.—RECONSTRUCTION OF THE BLOOD-SUPPLY OF THE APPENDIX, MAGNIFIED 16 TIMES.

The different coats of the appendix have been removed so as to show each layer and the character of its vascularization. Beginning from the left, we see the peritoneal or serous coat with its delicate vessels, and a few larger and tortuous ones. The next layer is the longitudinal muscle, the vessels of which run generally parallel with the muscle fibres. The veins in this layer anastomose very freely. The vessels of the next coat, the circular muscle, are also seen to follow the direction of the muscle fibres; they pass at right angles to the vessels in the longitudinal layer. There is free communication between the blood-vessels of the two muscular coats. The submucosa has been partly removed so as to expose the large plexus of vessels contained in its interior. This is the largest plexus of the appendix, and from it all the vessels of the submucosa and mucosa are derived. Owing to the large anastomosing trunks in the submucosa, it is possible to inject a comparatively large portion of the appendix through one of the subdivisions of the appendical artery in the mesentericolum. To the right is a cross-section of the appendix, permitting a view of the corrugated or folded mucous surface with its numerous glandular openings. The apices of the follicles, which reach the mucous surface, are not represented in this section. Along the upper margin of the mesoappendix is the main artery with its accompanying vein. From it the smaller branches run obliquely down to the appendix, dividing and subdividing at varying points before they reach the hilum. Some of the smaller branches enter the outer coats, while the larger trunks pierce the muscular layer at the hilum to form the submucous plexus. The veins in the mesentericolum anastomose much more freely than the arteries.

FIG. 25.—THE VEINS OF THE APPENDIX AND THEIR RELATION TO THE PORTAL AND SYSTEMIC CIRCULATION.

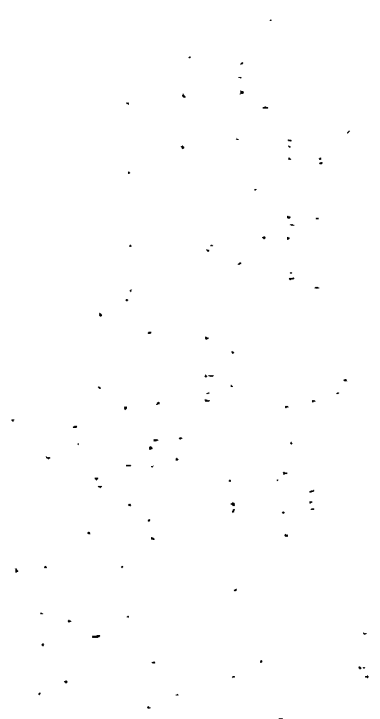
Above the diaphragm is seen the heart, imagined transparent so as to show the azygos veins and their communication with the veins of the œsophagus.

Lateral to the cæcum are a number of subserous branches, which establish a communication between the veins of the ileocaecal region on the one hand, and the veins in the iliac fossa on the other ; *i.e.*, between the portal and the systemic circulation.



FIG. 22.—The Veins of the Appendix and their Relation to the Portal and Systemic Circulation.

Above the diagram is seen the heart, enlarged transparent so as to show the arteries and their communication with the veins of the esophagus. In the center of the diagram are a number of arteries, branches which establish a communication between the veins of the lower abdomen on the one hand, and the veins in the line from the other; i.e., between the portal and the systemic circulation.



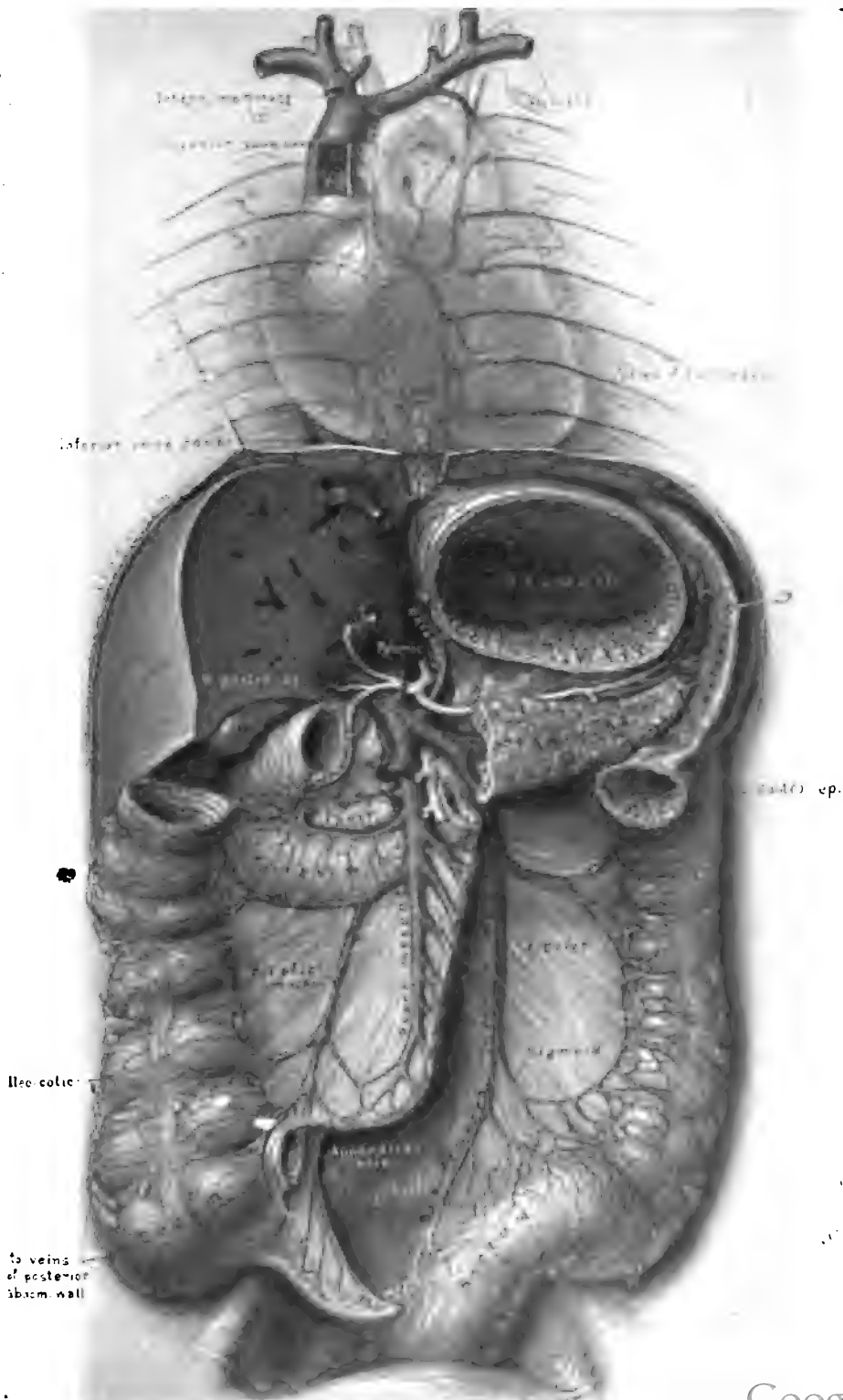


FIG. 25

FIG. 20.—A Representation of the Lymphatic System of the Appendix. Showing the Three Strata of Lymphatics. Modified from James.

The appendix is shown schematically so as to show the direction of the lymphatics in the blood. I. The superficial system is found in the serosa. It consists of a delicate network of lymphatics just beneath the peritoneum and a layer of larger blood-channels immediately beneath it. II. The middle system is situated between the muscular coat and submucosa; it carries comparatively few tributaries from the two coats. III. The deep system, forming a double layer at the base of the folds, receives the delicate finger-like capillaries of the mucosa and the channels coming from the lymphatics of the submucosa. The collecting channels of the deep system drain either into the blood stream or through the submucosa toward the hilum.

FIG. 26.—A RECONSTRUCTION OF THE LYMPHATIC SYSTEM OF THE APPENDIX, SHOWING THE THREE STRATA OF LYMPHATICS, MAGNIFIED 20 TIMES.

The specimen is drawn semitransparent so as to show the direction of the channels in the depth. I. The superficial system is found in the serosa. It consists of a delicate anastomosing network just beneath the peritoneum and a layer of larger beaded channels immediately beneath. II. The middle system, situated between the muscular coats and submucosa, receives comparatively few tributaries from the two coats. III. The deep system, forming a double layer at the base of the glands, receives the delicate finger-like capillaries of the mucosa and the channels coming from the lymph sinuses around the follicles. The collecting channels of the deep system drain either into the middle system or through the submucosa toward the hilum.

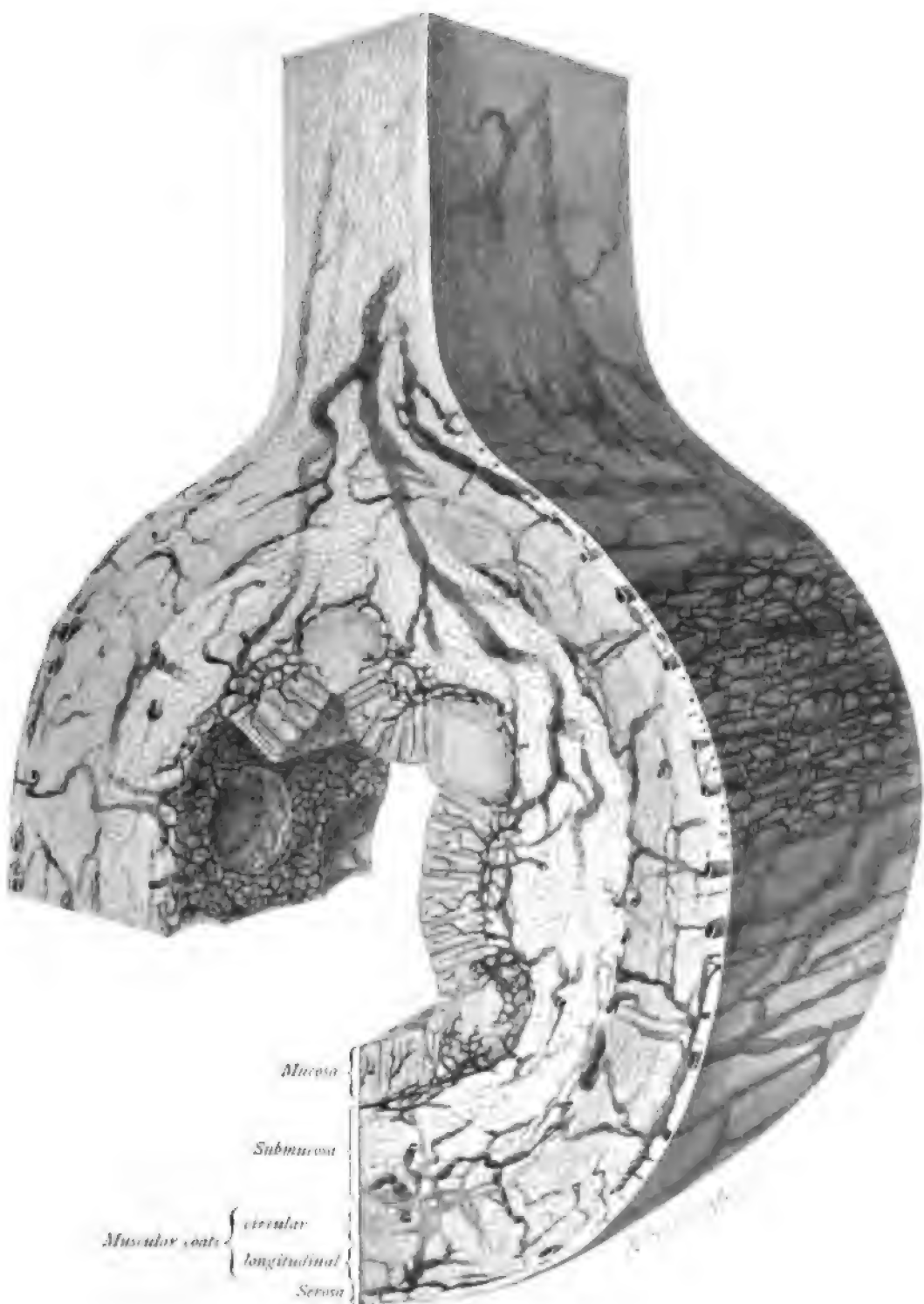


FIG. 26.

Under normal conditions, the blood from the appendix drains through the superior mesenteric and portal veins into the liver,—*i.e.*, from the periphery toward the centre. If the centre be the seat of an obstruction, the blood seeks other channels, which are found in a certain number of pre-existing collateral branches which establish a direct communication between the portal system and the venæ cavæ (Fig. 25).

Some of these venous anastomoses are as follows:

Communication between the coronary vein of the stomach, the veins of the œsophagus, and the v. azygos major, through which the blood reaches the superior vena cava and the heart.

Communicating branches exist between the veins of the cæcum, colon, appendix, and the adjacent peritoneum on the one hand, and the spermatic or ovarian on the other; or the blood drains into the ilio-lumbar vein or circumflexa ilium profunda, and through them into the inferior vena cava and heart.

There are occasional anastomosing twigs between the veins of the fixed portions of the alimentary canals; viz., duodenum (Retzius), hepatic flexure, and splenic flexure of the colon, as well as of those of the pancreas and the veins of the posterior abdominal wall.

The lymphatics of the appendix may be divided into the superficial, the middle, and the deep systems. A careful study of Fig. 26 will render any further description unnecessary.

While the lymphatic drainage of the appendix is mainly through the mesappendix into the ileocolic chain of glands, there are occasionally some small channels draining the proximal appendical portion into the cæcal trunks.

The appendical trunks (three to six in number) converge in the mes-appendix in an upward direction. As Figure 27 shows, these channels are in character similar to the posterior cæcal trunks, the only difference being the fact that they usually do not pass through isolated glands on their way up to the ileocolic glandular group.

In the majority of cases the first glandular station of the appendical lymphatics is in the mesentery of the ileocolic angle, from 1 to 3 cm. above the ileum. The appendical glands, rarely more than two in number, are generally situated at the lower median side of the ileocolic chain of glands.

In about three-fourths of the cases there are no glands in the mes-appendix, all the appendical lymphatics emptying directly into the mesenteric glands.

The nerves of the appendix are derived from the superior mesenteric plexus of the sympathetic system. The plexus envelops the vascular trunks, subdividing with them until the intestinal border is reached.

Here the nerves penetrate the different coats to form an outer and an inner system. The outer, or plexus of Auerbach, is situated between the longitudinal and circular muscular coats, where they form a complicated network, the individual branches of which terminate at the invol-

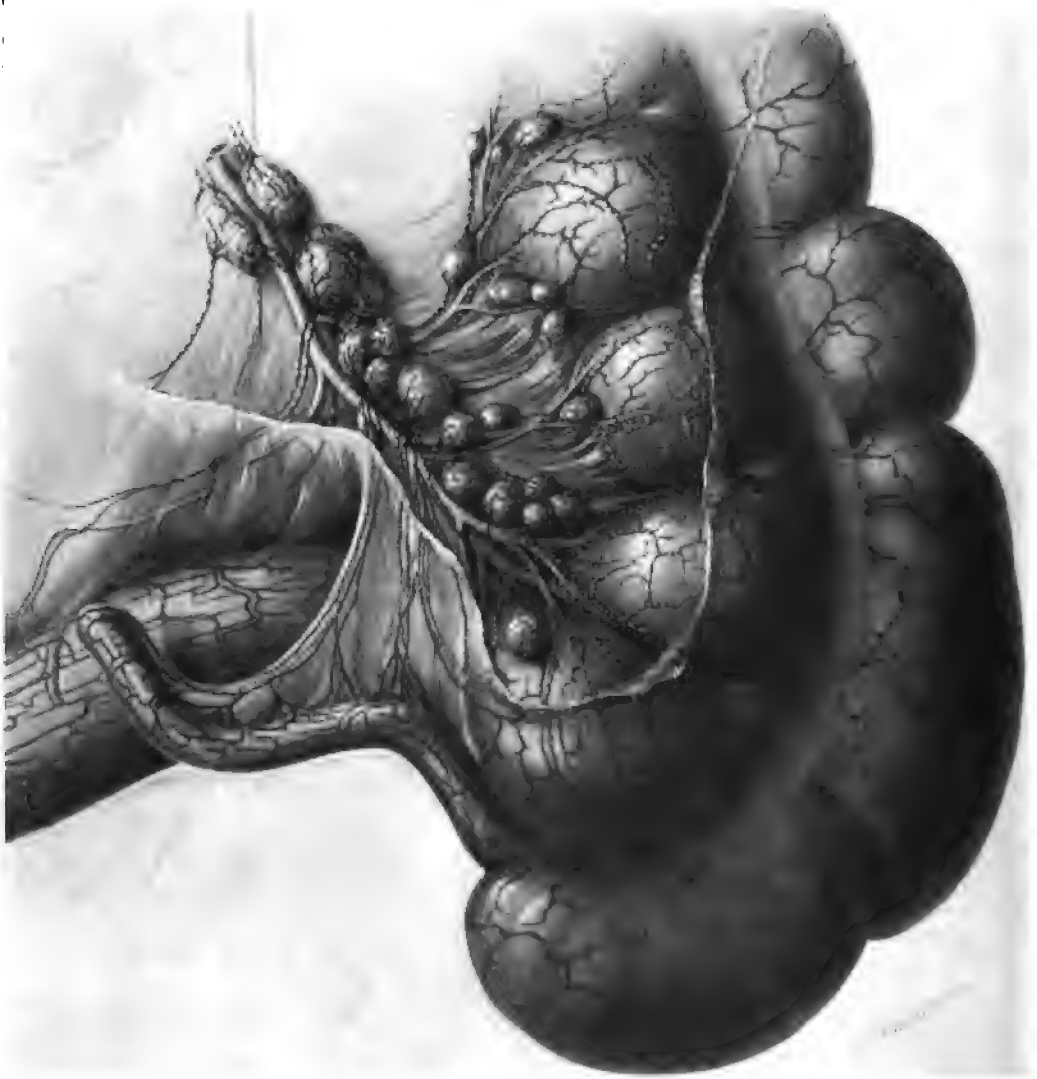


FIG. 27.—POSTERIOR VIEW OF THE ILEOCÆCAL REGION, SHOWING THE MAIN LYMPH-TRUNKS AND THEIR RELATION TO THE ILEOCOLIC CHAIN OF GLANDS.

The large size of the glands in this picture is due to their distention with injection mass. The glands are confined to the extraperitoneal portion of the mesocolon and intestine, the line of peritoneal reflection having a V-shaped outline, the apex being in the ileocolic angle.

The lymphatics of the appendix in this case are numerous. They drain into three glands. The lowest of these three receives besides the proximal appendical channels a few trunks coming from the distal portion of the cæcum. The gland might, therefore, be termed cæco-appendical. The lowest gland of the chain, situated just over the posterior cæcal pouch, has been described as Clado's gland and called appendical gland, as in the state of contraction of the bowel it may become lodged in the mesappendix. However, as this injection shows, this gland, if present, receives lymph from the cæcum and not from the appendix. In a very few instances it received a small tributary from the cæco-appendical angle.

untary muscle-cells of these layers. The inner system, the plexus of Meissner, is found in the submucosa. From this delicate fibres are seen to pass into the muscularis mucosæ, the rest passing upward and ramifying in the mucous membrane between the crypts, the end fibres being situated near or in the epithelium.

Meckel's Diverticulum.—Diverticula of the intestine are divided into two classes, false and true.

The false or distention diverticula are found anywhere in the alimentary canal, at the mesenteric border, at the sides, or at the free border. They are round and globular, with a somewhat contracted base, and their size varies from that of a pea to an apple, or they may be even larger. The individual coats of the intestine are not all continuous over these false diverticula, for on dissection the fibres of the muscular coats are found to be either much thinned out, or pushed aside altogether. These diverticula are therefore hernial protrusions of the inner coats through the muscle, and there may be a great number of them on the intestine of any one individual.

The true diverticulum, or Meckel's *diverticulum ilei*, represents the most frequent anomaly of the alimentary canal, occurring, according to various statistics, in from 0.5 to 2 per cent. of all bodies. It is found within a definite area of the ileum,—i.e., at a distance of 30 to 290 cm. from the ileocaecal valve, the most frequent measurement in the adult being 100 cm., in the newborn child about 30 cm. The diverticulum may, however, in rare instances be found outside the classic region, either high up (jejunum, duodenum) or far down (cæcum, colon), according to whether the upper or lower limb of the primitive intestinal loop has undergone excessive development. It is always single and all the coats of the intestine participate in its formation. Its shape is cylindrical, conical, or it may balloon at the extremity.

EMBRYOLOGY OF MECKEL'S DIVERTICULUM.—In the very young embryo the short and straight intestinal tube is still in open communication with the yolk-sac, which is situated directly in front of it. As the structures forming the body wall grow from the sides toward the front, they gradually narrow down the communicating portion between the intestinal tube and yolk-sac until it is but a narrow channel. This is the vitello-intestinal or omphalomesenteric duct, which normally becomes obliterated and absorbed as soon as the body wall of the embryo is closed. If it fails to disappear, it may persist in the adult as Meckel's diverticulum, of which we distinguish four different types. These represent, with tolerable exactness, the stages of embryological changes through which this peculiar structure has to pass.

Type I.—If the arrest in development has taken place before the closure of the opening of the gut in the yolk-sac has occurred, we find a broad fissure at the umbilicus, through which fecal matter is discharged. Associated with this condition is generally found another anomaly, dating

back to the same embryonic stage, namely, constricted or occluded anus (see Fig. 28).

Type I I .—This is a somewhat more advanced condition, in which the fissure is smaller, the canal longer, and, owing to an intact anal orifice, the intestinal contents pass in the usual manner. This type may be produced if at the time of birth a diverticulum still extended part of the way into the cord and became tied off with it, an ulcerative process developing in the diverticulum and leading to the formation of an umbilical fecal fistula (see Fig. 29).

Type I I I .—This is a still further advanced stage. The ventral fissure is now closed; the vitelline duct persists only in its proximal or ileal portion, forming a diverticulum which may be of various length,

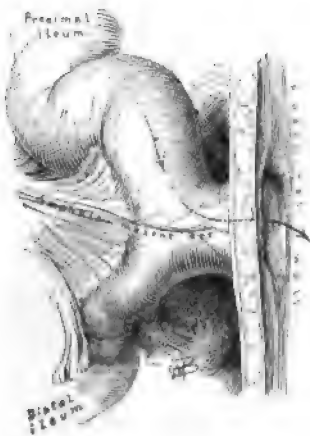


FIG. 28.—TYPE I. DIAGRAM OF THE MOST PRIMITIVE FORM OF MECKEL'S DIVERTICULUM, RESEMBLING THE ORIGINAL VITELLINE DUCT.

It appears as a short canal which connects the ileum with a ventral fissure, the extent of which may be considerable. The distal ileum is insufficiently developed, the anus being either constricted or occluded, and the intestinal contents pass through the fissure. The canal is accompanied by the remains of the omphalomesenteric vessels.

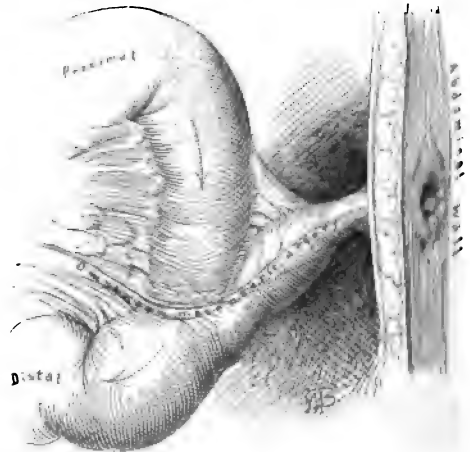


FIG. 29.—TYPE II. DIAGRAM OF A MORE ADVANCED FORM OF THE DIVERTICULUM.

The fissure persists, but is narrower, the canal longer and more slender, and, owing to an intact anal orifice, the intestinal contents pass in the usual manner. The omphalomesenteric vessels accompany the canal.

while its distal or umbilical portion has become obliterated and transformed into a fibrous cord which acts as a suspensory ligament for the diverticulum (see Fig. 30).

Type I V .—This is the form most frequently met with, and is that which is most apt to resemble a vermiform appendix. Here the ventral or umbilical portion of the duct has become absorbed and the ileal portion or diverticulum projects from the free border of the ileum (see Fig. 31).

The length of Meckel's diverticulum varies from 1 to 20 cm., 2.5 cm. being the most frequent measurement.

The width may be that of the ileum; more often, however, it is slightly less; it is occasionally very narrow, resembling a vermiform appendix (Fig. 32). Again, many cases have been noted in which a diverticulum was found two or three times as wide as the adjacent ileum.

The diverticulum is generally attached to the free margin of the ileum, *i.e.*, opposite the mesenteric border, in which case, however, its axis frequently points toward either one side or the other. It may, however, also come off at the sides or even near the mesentery. ORTH (*Lehrb. d. speciellen Path. Anat.*, vol. 1, p. 764) states that it may even be found extending between the leaves of the ileal mesentery; but it seems more likely that he has referred to a false or distention diverticulum. If attached to the free border the passage from one to the other is, as a rule, uninterrupted by any valvular structure. Not infrequently, however, the diverticulum is found leaning toward the ileum in a distal direction

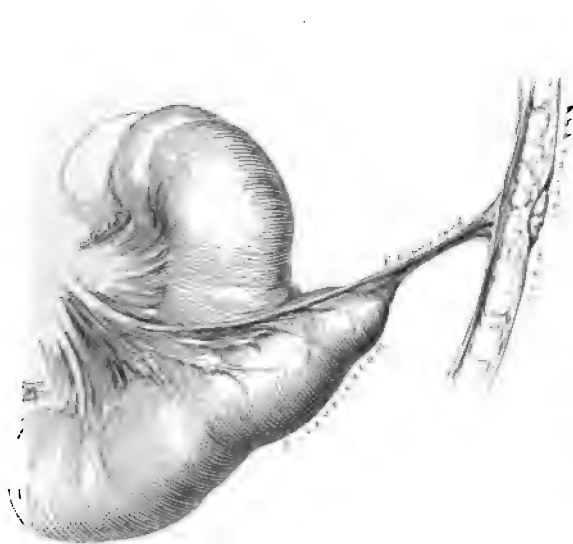


FIG. 30.—TYPE III. DIAGRAM OF A STILL FURTHER ADVANCED FORM OF DIVERTICULUM.

The ventral fissure is closed and the distal portion of the canal has become transformed into a fibrous cord which may or may not contain remains of the omphalomesenteric vessels. The proximal portion has retained its lumen and appears as a sac attached to the free border of the ileum.

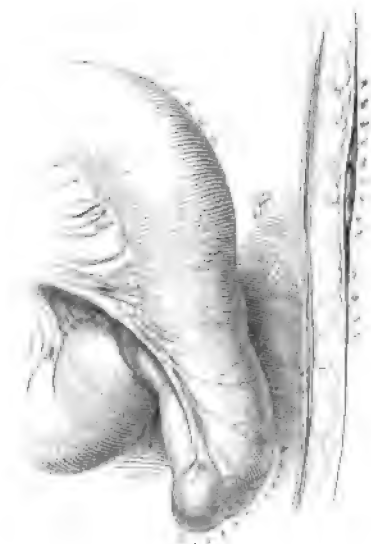


FIG. 31.—TYPE IV. THE USUAL FORM OF MECKEL'S DIVERTICULUM.

The proximal portion of the original vitelline duct persists, but, having become closed at its end and detached from the umbilical region, it appears as a pouch hanging free from the convex border of the ileum. The omphalomesenteric vessels run up to its tip.

(Fig. 33). The resulting acute angle between ileum and diverticulum gives rise to the formation of a semilunar valvular fold at the junction, similar in character to the semilunar fold at the cæco-appendical junction. The diverticulum may be closely adherent to the ileum for a variable distance, in which case the semilunar fold is still more pronounced (Fig. 32). MECKEL ("Ueber die Divertikel am Darmkanal," *Arch. f. d. Physiol.*, Halle, 1809, vol. 9, p. 421) thought that this narrowing and the presence of the valve signified a tendency on the part of the ileum to effect a normal closure at this point. If the fold projects from both the distal and the proximal margin of the orifice, this assumption is not without ground, and there are even instances where the opening was completely occluded

(ORTH, *loc. cit.*). If seen only on the side toward which the diverticulum leans, it should be regarded as of merely mechanical origin.

The tip of the diverticulum is a subject of interest, in so far as the muscular coats are here apt to leave gaps through which the inner coats may protrude. These hernial formations vary from the size of a pea to that of a walnut. They are identical in character with the above-described distention diverticula found at any point of the alimentary canal. We thus have a true Meckel's diverticulum with false diverticula at its cupola (Fig. 33). MECKEL (*loc. cit.*) has described this peculiarity and advanced



FIG. 32.—AN UNUSUALLY NARROW MECKEL'S DIVERTICULUM, WHICH MIGHT EASILY BE MISTAKEN FOR AN APPENDIX.

The resemblance is still more marked if viewed upside down. Careful examination of its mode of attachment and recognition of the fact that it arises from the ileum, will at once determine the true character of the structure. For a distance of 2 cm. the diverticulum is adherent to the ileum, and the resulting acute angle between the two gives rise to the existence of a semilunar valvular fold at the junction, which, however, does not suffice to prevent free communication between ileum and diverticulum. The diverticulum has a well-developed mesenterium arising from the mesentery, in which pass the omphalomesenteric vessels supplying the organ. Specimen from the pathological collection of the Johns Hopkins Hospital, 506. (Natural size.)

the opinion that in the development of the diverticulum the same energy is not expended as in the development of the intestine. The entire process should disappear, and it is not surprising that for this reason the remaining portion, on account of less firm texture, should frequently show traces of insufficient development, more pronounced in the last and weakest spot—the tip.

The muscular layers of the diverticulum are similar to those of the ileum,—viz., an inner circular and an outer longitudinal. The latter, however, is very delicate in some specimens, and may, in places, be wanting. The mucosa is also identical in character with that of the

ileum, and OSLER (*Ann. Anat. and Surg.*, 1881, vol. 4, p. 202) mentions a case in which a Peyer's patch was found in a diverticulum.

The blood supply is of sufficient interest to merit a brief description. The diverticulum is supplied by the remains of the vitelline or omphalomesenteric vessels. These belong to the first circulation of the

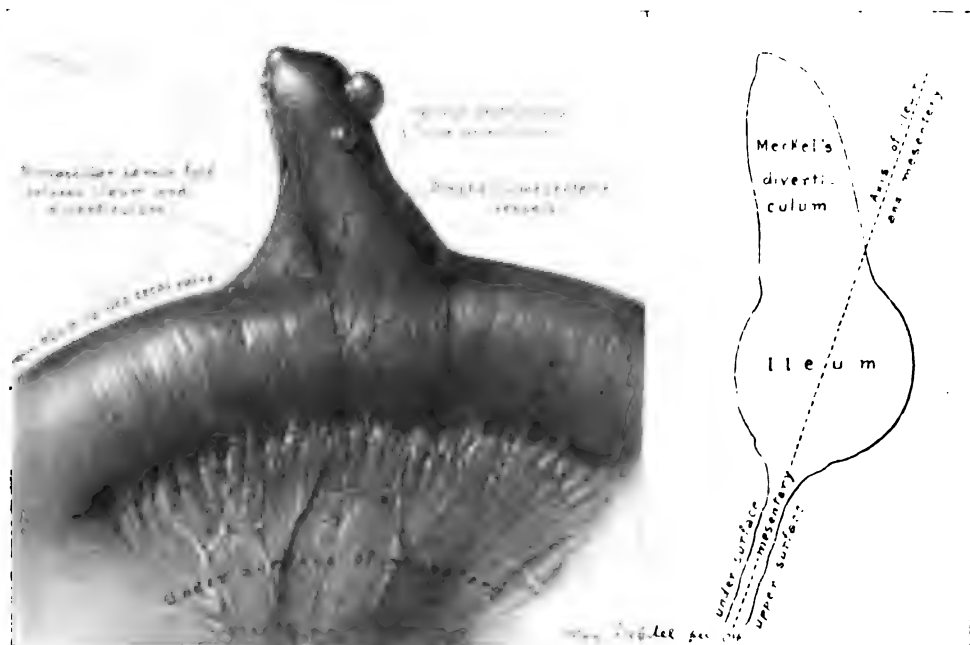


FIG. 33.—A MECKEL'S DIVERTICULUM ILEI WITH SEVERAL SMALL DISTENTION DIVERTICULA AT ITS DISTAL PORTION.

The diverticulum is situated at a point 45 cm. from the ileocaecal valve and attached to the free border of the ileum, pointing, however, slightly toward the under surface of the intestine. The omphalomesenteric vessels exist only on the under side (the embryonic left side), whence they send their branches around the structure. A triangular, transparent, non-vascular, serous fold runs in the distal acute angle between ileum and diverticulum. Observed June 6, 1904. (Natural size.)

embryo, and through them the blood of the vascular area inclosing the yolk-sac is carried into the two primitive aortas of the embryo. Veins accompany these arteries, which are at first multiple, but when the intestinal canal is formed they are reduced to two, one passing on either side of the intestinal tube. When the intestine bends away from the now single aorta to form its first loop, the primitive mesentery makes its appearance and the omphalomesenteric arteries unite to form one single vessel, which arises from the aorta and passes inside the newly formed mesentery to the most ventral portion, where it divides into two branches which pass right and left around the intestine and then into what remains of the vitelline duct and yolk-sac. The omphalomesenteric artery changes in later stages into the main trunk of the superior mesenteric artery, and the portion of the intestine in the adult toward which this artery points is the

region where the vitelline duct has been, and where we have to look for a Meckel's diverticulum.

Even if the diverticulum disappears, the omphalomesenteric artery may persist and run in a connective-tissue strand up to the umbilicus. This was the case in a man, fifty-four years of age, mentioned by HUNTINGTON ("Anatomy of the Peritoneum and Abdomen," 1903). The strand containing the omphalomesenteric artery may arise from the ileum or from the mesentery, and its presence among the intestines is undoubtedly an element of danger. According to ORTH (*loc. cit.*), this fibrous band may exist between the ileum and umbilicus without the presence of a divertic-

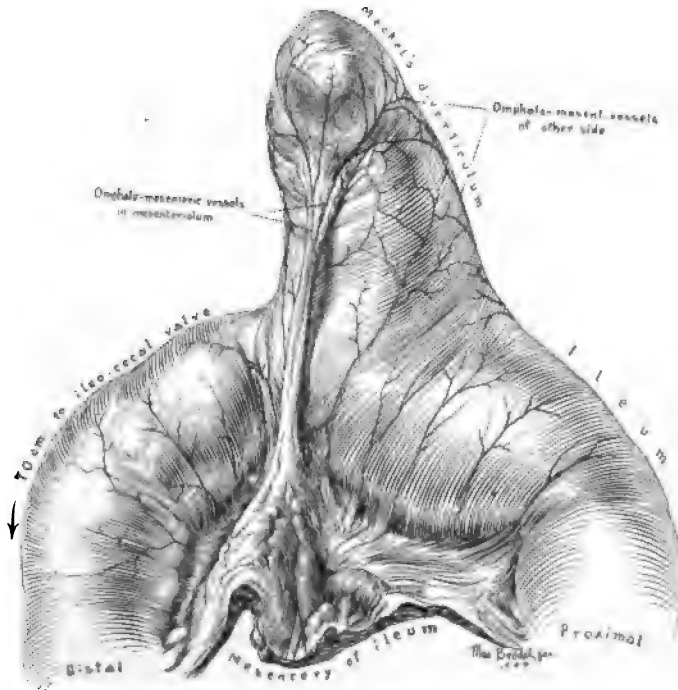


FIG. 34.—A LARGE MECKEL'S DIVERTICULUM 70 CM. FROM THE VALVE.

It is supplied by two omphalomesenteric arteries, one of which has given rise to the formation of a mesenterium on the under surface (embryonic left), while the other passes in close contact with the ileum and diverticulum along the upper surface (embryonic right). Broad anastomosing branches pass between the two. Autopsy, March 17, 1899. (Two-thirds natural size.)

ulum; or a diverticulum may be found adherent, with or without a band, not to the umbilicus but to another portion of the parietal or visceral peritoneum; and, finally, a band may arise from the umbilicus and be attached not to the intestine but elsewhere.

The diverticulum may be supplied by two persistent branches of the omphalomesenteric artery or there may be only one, the other having become atrophied. From the material at my disposal, it appears that the right (embryonic term) or upper branch is more apt to atrophy. In Fig. 33 the diverticulum is supplied by the left branch (embryonic term),—i.e., the one running around the under surface of the ileum. It courses along

the side of the diverticulum toward the tip, and gives off branches to right and left.

In case there are two omphalomesenteric arteries (Fig. 34), they ascend one on either side, but not exactly opposite one another. The branches given off form broad anastomoses with those coming from the other side. When viewed from the side, we see three or four superimposed vascular arches passing in intervals of 1 to 2 cm. from the right to the left omphalomesenteric vessel. They become shorter as they approach the tip. All arteries are accompanied by veins.

An important feature of the vascularization is the occasional presence of a mesenteriolum which contains the omphalomesenteric vessels. While in some instances in which the diverticulum is short and attached to a portion of the ileum equally far away from the mesenteric border, the vessels hug the ileum closely without lifting up any serous fold; in other instances, in which the diverticulum is long, or in which it arises more from the upper or lower side of the ileum, the vessels are very apt to lift up a serous fold of various size, which may contain a considerable amount of fat and resemble in every way the mesenteriolum of the appendix. It extends from the mesentery near the ileal border up to the tip of the diverticulum, but may also be shorter. Sometimes it forms a little fatty protuberance at the tip. It is evident that the development of such a structure is purely mechanical, resulting from the oblique position of a contracting and expanding tube in which the vessels were subjected to tension and lifted up a triangular peritoneal reduplication. Excessive distention of such a specimen shows clearly that tension of the vessels produced the mesenteriolum (Fig. 34). If there are two omphalo-mesenteric arteries, only one lifts up a mesenteriolum, *i.e.*, the one on the concave surface, while the other courses along the convex side of the ileum and diverticulum, accompanied by a varying amount of fat.

A diverticulum may also possess a non-vascular serous fold, which passes in the acute angle between the ileum and diverticulum. It is triangular in form and closely resembles the ileocæcal fold (Fig. 33).

It is worthy of note that Meckel's diverticulum is frequently associated with other anomalies; such as, harelip, cleft palate, insufficient development of the bones of the skull, spina bifida, congenital deficiency of septum of the heart, ventral fissure, double uterus, horseshoe kidney, double bladder, exstrophy of bladder, atresia of anus, club-foot, supernumerary digits, transposition of the viscera, double and triple monsters.

Another interesting feature is that a Meckel's diverticulum has been found in several children of the same parents, JAEGER (*Deutsche Arch. f. Physiol.*, Halle, 1817, vol. 3, p. 539) reporting two cases of infants with this anomaly, and RIEFKOHL (*Berl. kl. Wochenschr.*, 1874, vol. 11, p. 249) three, one of the three, however, being doubtful.

PATHOLOGY.—The presence of a diverticulum may give rise to a number of pathological conditions. The fibrous band passing from the tip of the sac to the abdominal wall or to any part of the viscera may form a ring in which the bowel can become strangulated. The existence of a valvular structure at the junction between the ileum and the diverticulum may cause a retention of the secretion of the mucous membrane of the diverticulum and give rise to the formation of a cystic dilatation, a so-called entero-cystoma.

Foreign bodies, such as cherry-stones, peas, orange pips (OSLER, *loc. cit.*), may enter a diverticulum and bring about inflammation and ulceration; while fecal concretions have not to my knowledge been reported.

Typhoid ulceration in a Peyer's patch situated in a diverticulum, with perforation, has been observed by GALTON (*Trans. Path. Soc. Lond.*, vol. 23).

A diverticulum may enter an inguinal hernia and become adherent with subsequent inflammation and perforation.

Finally, it may, on becoming inflamed, simulate in all respects an attack of appendicitis.

SYMPTOMS.—The symptoms of a diverticulitis are in all respects similar to those of an appendicitis, except that the pain may be situated somewhat higher up than is usual in inflammation of the appendix, as was noticed in two cases, by FINNEY. A good illustration of such a case has been furnished me by C. OVIATT, of Oshkosh, Wis., in a personal communication.

The patient, who was a man thirty-six years old, had had three well-defined attacks of appendicitis within a year. The last attack differed from the others in the fact that there were two distinct foci of pain and tenderness, one slightly below McBurney's point, the other about 12 cm. above it, nearly on a line with the umbilicus and at the outer border of the rectus muscle. He was admitted to the hospital when recovering from the third attack. At this time the upper focus was more sensitive to touch than the lower. The ordinary incision along the border of the rectus was made, and an appendix which contained a good-sized fecal stone removed. Upon extending the wound to the upper focus of pain, a mass of adhesions was encountered, which when freed showed a Meckel's diverticulum 8 cm. in length and about two-thirds the size of the ileum. It had evidently been but recently in a state of active inflammation similar to that in the appendix. The diverticulum was removed close to the ileum, and the wound closed with the Czerny-Lembert sutures; the abdominal wound was closed without drainage. The patient made a good recovery.

TREATMENT.—The operation for diverticulitis consists in the detachment and isolation of the diverticulum, extreme care being taken not to rupture its tender coats. The mesentery, if present, is ligated, and the diverticulum also is ligated near the ileum, the bowel wall being kept well elevated, and pinched together to prevent any escape of its contents. The wound is then closed with mattress sutures, which are again turned in with seroserous sutures. If a large diverticulum is caught in a hernia and strangulated, it may be necessary to resect the bowel in part, or even across its entire lumen.

CHAPTER III.

PHYSIOLOGY.

HAS the vermiform appendix any function? If so, what is that function, and is it of any value in the animal economy? These are questions which have interested physiologists for more than a century, and seem to be still as far from solution as ever.

Presumption is all we have as yet to guide us in answering the question: Has the vermiform appendix a function? But, while presumption from analogy and from accessory data may suggest an affirmative answer, an ultimate decision must rest upon the crucial test of demonstration. The argument from presumption, briefly stated, is as follows: We have in the appendix a distinct division of the alimentary tract, present in man, in apes, and in rodents. Its position in relation to the cæcum is such as to promote the escape of its own secretions, while hindering the ingress of foreign bodies and fecal matter. Moreover, the minute anatomical structure of the appendix has characteristics especially its own, being peculiarly rich in lymphoid tissue, and so closely related to the tonsils in this respect that a near relation between the two as regards function is maintained by some observers.

The most important evidence, however, in favor of a function of economic value attached to the appendix, is the fact that, instead of atrophying before or shortly after birth, it actually, in embryonic life, replaces a primordial appendix (see "Embryology of the Appendix," Chap. II) and then goes on to full development, persisting throughout adult life, and even into extreme old age, partaking and sharing only in those atrophic changes of the body at large which are the index of senility.

Against these facts, on the other hand, we have the numerous experiments performed *in vivo* by surgeons, in which healthy or relatively healthy appendices are often removed without deleterious effect.

It is necessary for us to accept for a moment the argument from analogy in favor of a function belonging to the appendix, in order to reach our second hypothetical question: What may that function be? Is it nothing more than a share in the general intestinal system; or is it of a peculiar and special character? Do the glands of the appendix merely add numerically to the total number of microscopically similar glands scattered at greater intervals throughout other parts of the intestine, or do they secrete some as yet not isolated chemical substance exercising a special influence upon digestion at this point in the alimentary tract? The argument from analogy for a special function may be briefly stated thus: In the first place, the functions of a number of organs heretofore considered

functionless, as the thyroid, thymus, and suprarenal glands, have proved of such inestimable value—nay, so necessary to normal life—that the scientific physiologist will do well to reserve his judgment in regard to the appendix, and occupy an attitude of expectant observation. Again, as in the upper part of the digestive tract special secretions are poured in from such important organs as the liver and pancreas, so in the lower may we not expect, after the sudden transition from ileum to colon, to find some analogous organ or organs profoundly modifying the food under its altered conditions?

In summing up the evidence, I can only repeat that we await the final test of demonstration. Anatomy makes plain to us the structural peculiarities of the appendix, but leaves us entirely in doubt as to the existence of a function; it remains for the physiologist, or more properly the physiological chemist, to detach the appendix in some animal suited for the purpose, turn it into the surface of the body and study its secretions, for by demonstration alone, as I have said, can the question of function be finally determined.

Before leaving the subject, I think it will be of interest to give a brief account of the opinions held by different distinguished writers of an earlier date, beginning with the great LIEBERKÜHN.

J. N. LIEBERKÜHN (*De Valvula coli et usu processus vermicularis*, I. D., Lugd., Bat., 1739) says: "The surface of the vermiform appendix is full of glands secreting a fluid which mingles with the fæces in the cæcum, and by diluting these prevents their remaining stationary and doing harm. Glands of the same character are present in the cæcum, but those of the appendix possess greater strength and usefulness. The fact that the appendix contracts at the same time as the cæcum, prevents any foreign body entering its lumen."

J. VOSSE (*De intestino cæco ejusque appendice vermiformi*, I. D., Götting., 1749) says: "The uses of the vermiform appendix are as yet imperfectly understood, but when the character of its structure is considered, it will be seen that its uses are other than those of the cæcum. The surface of the appendix is full of glands, which secrete a mucous, or rather a gelatinous layer. As there is naturally a tendency for fæces to accumulate and harden in the cæcum, there must be some provision by which they are rendered more fluid. Glands are present for this purpose in the cæcum, but they are not sufficient and require aid. The function of the vermiform appendix is to provide additional secretion."

HERLIN (*Jour. de méd. chir. et phar.*, July, 1768, p. 321) published some observations in regard to the appendix which assume that its function is mechanical.

G. VON DEM BUSCH (*De intestino cæco ejusque processu vermiformi*, I. D., Götting., 1814) emphasizes the view taken by LIEBERKÜHN as to the secretion from glands in the appendix poured into the cæcum. "If," he says, "the vermiform appendix yields a mucous secretion, and if this secretion is the same as saliva and pancreatic juice"—which he assumes as probable—"then the appendix must be considered as a second salivary or pancreatic gland, while the cæcum is a second stomach."

The next contribution to the subject which I have found is that by H. CUMMIN, in the form of a letter (*Med. Times and Gaz.*, 1852, vol. 2, p. 498) in which he suggests that the appendix is a remnant of intra-uterine life, like the umbilical ring and the fossa ovalis. In a series of dissections of the human foetus at different stages of growth, which had extended over some years, he had always found the colon tapering into the vermiform appendix. He had also, once, in a very young subject, found the extremity of the appendix attached to the peritoneal surface of the umbilical ring. Reflecting on these facts, he says, and remembering that the umbilical vesicle and the white filament extending from it are now admitted to be the empty yolk-sac and its duct, he has been led to the conclusion that the vermiform appendix is undoubtedly the anatomical termination of the vitelline duct. Anatomists who will take the trouble to make the dissections above alluded to, and to observe the gradual expansion of the appendix into the colon as well as the length of the tapering gut from the point at which the ileum enters, will, he thinks, agree with him.

I have found nothing further upon the subject, beyond passing conjectures, until the year 1888, a period when our knowledge of the appendix was entering upon its present era. H. H. SMITH ("The Appendix Vermiformis, its Function, Pathology, and Treatment," *Jour. Amer. Med. Assoc.*, 1888, vol. 10, p. 797) then writes as follows: "That the appendix exerts some influence on the action of the cæcum in digestion is quite probable, as its mucous coat differs very materially from that of the cæcum and colon in the arrangement of capillaries and mucous crypts, as shown by the minute injections made by Neill of Philadelphia, in 1851; whilst Gerlach states that the intervening spaces between the crypts of the appendix are so prominent as to make them look like small bridges—a marked anatomical difference. With this vascular structure, we may well suppose that the secretion of the appendix is free, and differs in some way from the cæcum. Perhaps it is the source of a lactopeptone mixed with a large amount of mucus and some phosphates or some carbonate of lime, that in some way modifies the formation of feces, and by its mucous secretion facilitates their passage up the ascending colon; hence, an early symptom of appendicitis is constipation. The presence of an appendix vermiformis in certain herbivorous animals and its absence in the carnivora, would also seem to indicate that this organ has some influence on the digestion of vegetable matter. Tiedeman and Gmelin long since observed that the gastric juice of the herbivora possessed this power, whilst that of the carnivora (that have no appendix) is not sufficiently active to destroy coarse vegetables, cereals, or hay and straw."

We proceed now to another question of physiological interest, namely: Has the appendix any proper movements? Every observer who has examined appendices with the abdomen open, and noted the length of the appendix before and after removal, must often have been struck by the fact that an appendix of some length within the body often appears much shorter when removed, and that an appendix

which is flaccid *in situ naturalis* sometimes becomes firm and even rigid when excised and laid upon the table. I have myself seen an appendix, measuring 9.5 cm. before removal, contract to a little over 4 cm. after it was removed; and VAN LENNEP mentions a case in which the appendix appeared to be in spasmodic contraction and full of something that could not be emptied by compression, but as soon as it was removed and laid upon a plate, it spontaneously expelled a mass of soft fæces (*Hahn. Med. Month.*, Jan., 1895). No definite observations recording contractions of the appendix have as yet been published; and therefore the following piece of practical work by E. HURDON is of special value, giving, as it does, a graphic representation of the contractions of the appendix in the rabbit in response to stimulation by electricity.

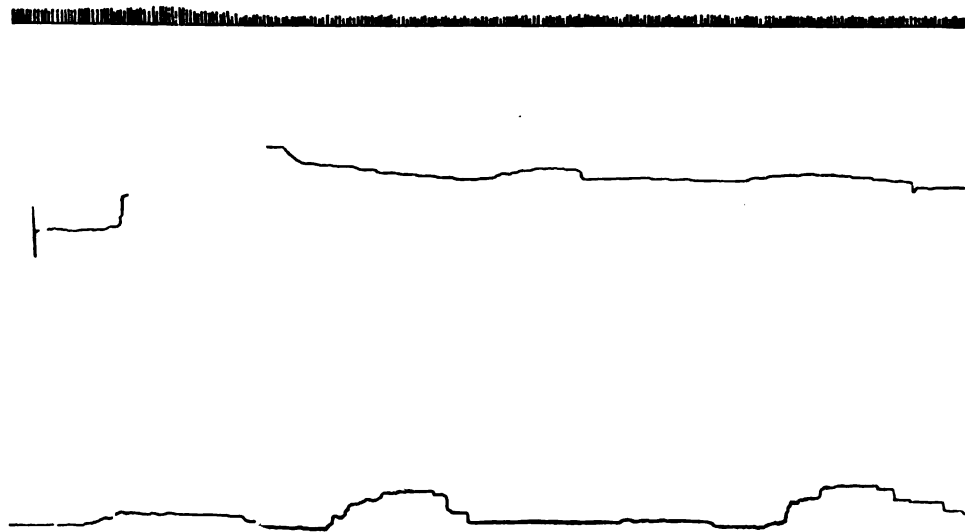


FIG. 35.—The larger curves indicate the peristaltic waves, and the secondary curves the simple muscular contractions. The respiratory movements are indicated by the undulations.

The apparatus used was similar to that employed by BAYLISS and STARLING (*Jour. Physiol.*, 1899, vol. 24, p. 99) in their experiments on rabbits, with a few unimportant modifications. The abdomen of a medium sized rabbit was opened under normal salt solution, at a temperature of 37.5°C .; a longitudinal incision was then made in the wall of the cæcum, on the side opposite to the attachment of the mesentery, and a balloon inserted. The appendix was next brought out of the abdominal cavity and immobilized on a small stand, after which the levers were attached to it by sutures. The point where the balloon was inserted was then fixed, so as not to interfere with the motion of the levers. Small regular contraction waves followed the insertion of the balloon, and continued to do so. Inflation of the balloon was followed by deep regular peristalsis, plainly visible and clearly recorded on the drum (see Fig. 35).

CHAPTER IV.

BACTERIOLOGY.

CHAUVEAU in 1882 (*Lyon méd.*, 1882, vol. 41, p. 272) demonstrated that the injection of micro-organisms into the abdominal cavity might be followed by peritonitis, and PAWLOWSKY in 1887 and 1889 (*Centrbl. f. Chir.*, 1887, vol. 14, p. 881, and *Virchow's Archives*, 1889, vol. 117, p. 469) produced the condition by the use of virulent micrococci, while WEICHELBAUM in 1888 (*Centrbl. f. Bakteriolog.*, 1888, p. 33) showed that peritonitis might be caused by *Micrococcus pneumoniae*. The accurate investigation of peritonitis in its relation to appendicitis may be said to have begun, however, with LARUELLE, who in 1889 isolated *Bacillus coli* from the exudate in a general peritonitis following an inflammatory process in the appendix. He was quickly followed by E. FRÄNKEL (*Munch. med. Wochenschr.*, 1890, p. 23) and PREDÖHL (*ibid.*, p. 22), both of whom examined a considerable number of cases and came to an almost identical conclusion. Fränkel found *Streptococcus pyogenes* in the majority of the 15 cases which he examined, and therefore believed that this organism played the chief rôle in the etiology of peritonitis, the other bacteria present being secondary invaders from the intestinal tract, in which view Predöhl agreed, in spite of the fact that he himself found a mixture of bacteria in his culture tubes.

A year later (1891) FRÄNKEL examined 31 cases of peritonitis associated with appendicitis, and found *Bacillus coli*, *Bacterium aërogenes*, *Micrococcus pneumoniae*, and *Micrococcus aureus* present in addition to *Streptococcus pyogenes*. The cultures of *Bacillus coli* obtained by Fränkel proved virulent to smaller animals—a fact which convinced him that this organism played no small part in the etiology of appendicitis.

From this time forward, two distinct views have been held in regard to the bacteriology of appendicitis, each being advocated by accurate observers, and supported by careful examinations of inflamed appendices. On the one hand, a number of bacteriologists have isolated *Streptococcus* from the peritoneal exudate in the majority of their cases, either alone or in combination with other organisms, and, therefore, they consider that this organism, which is capable of setting up most extensive and virulent inflammations in other parts of the body, as well as pronounced and fatal infections, must also be responsible for inflammation of the appendix and resulting peritonitis. On the other hand, many investigators have utterly failed to isolate *Streptococcus* from the pus about the appendix, or in the general cavity of the abdomen, finding instead

Bacillus coli, or some other organism derived from the intestinal tract, and, as they are unwilling to admit that they have missed *Streptococcus* (although it is notoriously easy to overlook), they regard other bacteria as the causative agents in appendicitis. It must be admitted, however, that their views have received considerable support from the fact that *Bacillus coli*, originally looked upon as non-pathogenic, can, in rare instances and in large doses, produce a fatal hemorrhagic peritonitis in rabbits.

A few of the more important investigations bearing on this question are the following: MALVOZ (*Arch. de méd. experim. et d'anat. path.*, 1891, p. 593) found *Bacillus coli* in 6 cases of peritonitis without perforation, and WELCH (*Med. News*, 1891, vol. 59, p. 669) found it in 3 cases subject to intestinal ulceration, as well as in several cases of appendical abscess. Both *Streptococci* and *Micrococci*, however, were found with the *Bacillus coli*. In 1892 JALAGUIER (*Bull. et mém. Soc. de Chir.*, 1892, vol. 18, p. 391) isolated *Bacillus coli* from the exudate in peritonitis following perforation, together with *Micrococcus aureus*, *Bacillus subtilis*, and *Bacillus lacticus*, but CLADO, in 10 examinations found only *Bacillus coli*. On the other hand, KÖRTE in 1892 (*Arch. f. klin. Chir.*, 1892, vol. 44, p. 612), after examining 19 cases, reported that he found *Streptococcus* and *Micrococcus* in the majority of them. TAVEL and LANZ (*Mittheil. a. klin. u. med. Instit. der Schweiz*, 1893, Reihe 1, Hft. 1) investigated 24 cases of appendicitis, studying carefully the different organisms encountered, and determined these to be *Bacillus coli*, *Bacillus pyocyaneus*, *Bacillus foetidus liquefaciens*, *Diplococcus intestinalis*, both major and minor, *Diplococcus liquefaciens*, *Diplococcus pneumoniae*, and *Streptococcus pyogenes*, besides a bacillus belonging to the diphtheritic group, and one belonging to the glanders group. They also found a number of organisms in the microscopic examinations of the exudate which could not be obtained in pure culture, organisms resembling *Actinomyces*, besides *Bacillus tetani*, some sarcina forms, and some other bacteria taken to be anaërobes, and, as they found in several cases that only *Bacillus coli* could be cultivated out of a mixture of different organisms seen in the pus, they concluded that its importance had been much exaggerated by previous observers. Other important investigations are those of HARBITZ (*Noesk. Mag. for Laegevidenskaben*, 1896, p. 461), who in 14 cases of appendicitis found *Bacillus coli*, *Streptococcus* and *Micrococcus*; those of ACHAUD and BROCA (*Bull. et mém. de la Soc. méd. des hôp. de Paris*, 1897, p. 442), who in 20 cases found *Bacillus coli* alone 7 times, *Bacillus coli* together with *Streptococcus*, *Pneumococcus*, and *Micrococcus* 10 times, with only 3 cases in which *Bacillus coli* could not be isolated; and those of

DEAVER (*Ann. Surg.*, 1898, vol. 27, p. 303), who in 200 cases found a mixture of *Bacillus coli*, *Streptococcus*, and *Micrococcus* usually present.

The foregoing observations apply only to the bacteria which can be cultivated by ordinary means, and which grow in the presence of oxygen. The conditions around the appendix and in the general cavity of the peritoneum, however, favor the development of pure anaërobic bacteria, that is, bacteria growing only when oxygen is excluded, as well as those growing indifferently in the presence or absence of this substance; hence, we should expect to find a considerable number of bacteria of that character in the exudate. There is every reason to believe this is the case, but the only extensive investigation bearing out the supposition is that of VEILLON and ZUBER (*Arch. de méd. experim. et d'anat. path.*, 1898, p. 517), who in 22 cases of gangrenous and fetid inflammation of the appendix, found pure anaërobes mixed with *Bacillus coli* and *Streptococcus* in 19 cases. They determined 5 different species of anaërobes,—namely, *Bacillus fragilis*, *Bacillus ramosus*, *Bacillus perfringens*, *Bacillus fusiformis*, and *Bacillus furcosus*, which they considered responsible for the gangrenous conditions of the appendix and for the intoxication. Finally, KROGIUS (*Finska Lakaresällskapets handlingar*, 1899, p. 1198) investigated 40 cases of appendicitis and peritonitis, isolating *Bacillus coli* 35 times, *Diplococcus pneumoniae* 21 times, *Diplococcus intestinalis* 6 times, *Streptococcus coli gracilis* once, *Streptococcus pyogenes* once, *Bacillus pyocyaneus* twice, and *Proteus vulgaris* once. In 7 cases he found only *Bacillus coli*; in 27 cases, a mixture of two or three different species; and in only 3 cases did the cultures agree with the results found in the original examination of the exudate. He also found 2 species of anaërobes which he identified as the forms described by Veillon and Zuber as *Bacillus ramosus* and *Bacillus perfringens*.

Investigations at the Johns Hopkins Hospital bear out in general the observations of Krogus and those of Tavel and Lanz, although some difference in results naturally arises from the different means employed for the identification of the bacteria. Nearly 1000 cases of disease in the appendix were examined bacteriologically, and the results obtained from the entire series may be briefly summarized by the study of 100 cases taken quite at random from the surgical records. Thus, in 100 cases of appendicitis in which either the lumen of the appendix, the peri-appendical tissue, or the general cavity of the abdomen was examined, the *Streptococcus* was found in only 16 cases, while *Bacillus coli* was present in 86. *Bacillus lactis aërogenes* was obtained in 10 cases, and members of the hog cholera group in 10 cases. *Bacillus pyocyaneus* was found in 2 cases, *Bacillus fecalis alcaligenes* in 3, *Proteus vulgaris* in 4, and

Bacillus aerogenes capsulatus of Welch in 4 cases. In the majority of the cases, several species of organisms were isolated side by side, no matter whether the lumen of the appendix only was examined, or a localized peritonitis around the appendix, or a general inflammation of the serous membrane.

This brief summary of evidence makes it plain that the results obtained by different investigators on this subject are remarkably in accord, taking into consideration, of course, that the experiments were carried on in laboratories situated in countries widely separated by distance, and by bacteriologists, each of whom employed a technic characteristic of his own laboratory. This striking agreement is accounted for by the fact that the conditions existing in the cæcum and appendix are practically uniform, not only in the normal state of the organs, but even when the appendix is attacked by disease or affected by the sequelæ to inflammation of it. We believe that the bacteria found in inflammatory conditions of the appendix are present in the normal intestinal tract in all cases except those rare and not well authenticated instances when appendicitis develops during the course of an infectious disease, a condition under which it has been stated that inflammation in the appendix may be set up by the organisms causing the original infection.

The cæcum is the point which offers the very best conditions in the entire intestinal tract for the development of bacteria. In the stomach, organisms taken from the external world find a medium too highly acid for their rapid multiplication; in the small intestine, bacteria meet with insufficient pabulum to sustain life; therefore, it is only when the ileocæcal valve is reached that we find conditions allowing an abundant development of micro-organisms. Here the reaction is favorable to the growth of bacteria, and sufficient undigested food is present to supply the nutriment necessary to their increase. Not only are plates taken from this region thickly crowded with colonies, but the greatest diversity of the forms cultivated is thus obtained, even under ordinary methods of isolation. By special technic the number of different bacteria found in the ileocæcal region may be greatly increased, the number of bacteria in diseased conditions of the bowel, even in normal conditions, being always much augmented. By direct continuity, the bacteria spread from the cæcum to the lumen of the appendix, in which the flora is identical with that of the cæcum, so far as the varieties of micro-organisms are concerned. Hence, we have the most favorable conditions for the rapid development of bacteria through to the walls of the appendix, and the initiation of an inflammatory process, the limitations of which will be largely although not entirely determined by the virulence of the invading micro-organisms. The following species, in our estimation, are of greatest importance in initiating and extending inflammations of the appendix.

Streptococcus pyogenes (Rosenbach, 1884).—This organism can be isolated in only the minority of cases of appendicitis; nevertheless, it must be considered as of the greatest importance etiologically in the

causation of the disease. It is especially associated with all cases of very severe infection, and is the usual cause of extensive and rapidly fatal peritonitis. It is, however, an organism somewhat difficult to cultivate artificially, even when present in pure culture, and when associated with other micro-organisms it is often overgrown by bacteria, which, although more viable, are not more virulent. Its colonies, which are small and almost transparent, are easily missed in examining both agar and gelatin plates. It is, however, a normal inhabitant of the intestinal tract, especially the portion of the cæcum near the appendix. The *Streptococci* are organisms possessing great variability in virulence, some species being capable of setting up rapidly fatal infections, while others, on the contrary, limit their pathogenic action to the production of local abscesses. It is impossible to estimate the virulence of any given species without extensive animal experimentation, but its demonstration in the pus of appendicitis must be invariably regarded as of the gravest prognostic significance. Morphologically, it is apt to grow in the tissues simply as a diplococcus or as short chains, only assuming its characteristic appearance after several generations on artificial media.

Bacillus coli communis (*Bacillus coli*, Migula, 1900).—This organism, originally discovered by ESCHERICH in the dejecta of infants, has since been shown by numerous observers to exist normally in the intestinal tract of man, as well as to have a wide and extensive distribution in Nature. Morphologically, it appears as a small plump bacillus, slowly motile, and possessing universal flagella. It is easily cultivated on all artificial media in the laboratory, growing abundantly as a whitish-yellow deposit on surface of solid media, always acidifying and coagulating milk, and breaking up the carbohydrates with the evolution of acid and gas, but not liquefying any proteid material. Originally supposed to be lacking in any pathogenic action, it has now been shown to possess considerable virulence—its various species differing greatly in this respect. Intravenous and intraperitoneal injection of large doses will kill smaller animals, and epidemics among them have been found, in many cases, to be caused by organisms differing in no essential particular from typical cultures from the intestinal tract of man. Certain species of *Bacillus coli* are especially prone to set up hemorrhagic peritonitis, and its pus-producing properties have long been recognized by observers who have found it in superficial abscesses, it having been originally described in this location as *Bacillus pyogenes foetidus*. It occurs in the pus of general peritonitis, in abscesses around the appendix and in its lumen; sometimes in pure cultures and sometimes mixed with other micro-organisms. It is the most common secondary invader in all cases of appendicitis and peritonitis caused by the *Streptococcus* or by other organisms, and it may have an exalted virulence, when associated with other bacteria. Not only can *Bacillus coli* be obtained from those cases in which other and more virulent bacteria are found, but in a large number of cases it is the only species which can be isolated. In these cases the micro-

scopic examination of the exudate is confirmed by the cultural experiments, and no evidence exists to show that the *Streptococcus* was present and was overlooked. Moreover, the type of the disease in these cases is much milder than in those in which *Streptococci* are found, the inflammation being often limited to the tissues in the immediate vicinity of the appendix, the resulting peritonitis being less extensive and less severe, besides manifesting a greater tendency to the formation of localized abscesses, with the production of large quantities of pus of a peculiarly fetid character.

Bacillus pyocyaneus (*Pseudomonas aeruginosa*, Migula, 1900).—This organism, known for a long time as the "bacillus of blue pus," occurs in the contents of the intestinal tract in a large number of cases, in so many, indeed, that it may be looked upon as a normal constituent of the alimentary canal. Morphologically, it is a very small, actively motile bacillus, characterized by its imparting to all culture media a green color, now known to be due to the production of the pigments fluorescin and pyocyanin. It is easily cultivated in all satisfactory media, and is separated from the other fluorescent organisms by its ability to break up proteid material, such as gelatin, casein, and blood-serum, causing their complete liquefaction, and also by its inability to split up carbohydrate solutions. It is possessed of considerable pathogenic properties. When introduced into the genito-urinary system it may set up extensive infections, ascending from the bladder to the ureters and kidneys, or it may invade the body through a superficial lesion of the intestinal mucosa and originate a systemic infection with fatal outcome. Experimentally, *Bacillus pyocyaneus* can occasion an extensive hemorrhagic and fibrinopurulent inflammation of the peritoneum, rapidly causing death when introduced into the abdominal cavity of smaller animals. There are a small number of cases in which its relation to appendicitis has been well demonstrated, but it has been reported in this connection only a few times, and at the Johns Hopkins Hospital it is found to be one of the rarer pathogenic agents encountered in this disease. It is possible that it originates inflammatory processes in the appendix, but more probably it is a secondary invader of structures already diseased.

Bacillus proteus vulgaris (*Bacillus vulgaris*, Migula, 1900).—*Proteus* forms, including several distinct species, are normally found in the intestinal tract, and occasionally, though rarely, in the pus around the appendix, as well as in peritonitis. They are easily recognized on the surface of agar and gelatin by their characteristic spreading colonies. Experimentally, these bacilli can originate extensive inflammation of the peritoneum in smaller animals, resulting in death, but their pyogenic properties in man are still problematic. They are rarely met with alone in appendicitis, being usually associated with other bacteria. It is probable that they seldom initiate the morbid process in the appendix, but, like many other intestinal bacteria, they travel through a ruptured intestinal wall in the wake of more actively pathogenic agents.

Micrococcus pyogenes (*Micrococcus aureus*, Migula, 1900).—The *Micrococci*, or, as they are usually called, the *Staphylococci*, occur but rarely in the inflammation of the peritoneal cavity. Morphologically, they appear as collections of spherical organisms, whose tendency to assemble in groups like bunches of grapes gave them their original appellation. They are easily cultivated artificially, but they may be recognized by their characteristic appearance under the microscope. Many species are possessed of great virulence, especially the “golden yellow coccus,” and when associated with other bacteria, especially the *Streptococci*, they may give rise to the collections of pus often seen about an inflamed appendix. They rarely cause a general peritonitis, but when present in pure culture, they generally confine their pathogenic action to the peri-appendical tissues.

Pneumococcus (*Diplococcus*) (*Streptococcus*) (*Micrococcus pneumoniae*, Weichselbaum, 1888).—In our opinion this organism plays a very doubtful rôle in the etiology of appendicitis and appendical peritonitis. It has been reported as present by a number of observers, notably by KROGIUS, who has contributed the most extensive series of cases; but the grounds for its identification are not always of the soundest. It closely resembles *Streptococcus* in its cultural reactions, as well as in its colonies on agar and gelatin, but it can be positively identified only by the definite demonstration of a capsule or by positive criteria; organisms which resemble the *Pneumococcus* should usually be classed as *Streptococci*. In an experience extending over a decade in the laboratory of the Johns Hopkins Hospital, there have been 3 cases in which *Micrococcus pneumoniae* was undoubtedly the cause of peritonitis, and not one of these was the result of appendicitis. The *Pneumococcus*, moreover, does not occur ordinarily in the contents of the cæcum. Taking all these facts into consideration, its importance in the etiology of appendicitis becomes minimized. In rare instances it may reach the appendix from the lungs, being carried there by the blood stream, and in that event it may cause inflammation of the organ.

Bacillus lactis aërogenes (*Bacterium aërogenes*, Migula, 1902).—This organism is the capsulated bacterium normally present in the intestinal tract of all individuals. Its cultural reactions are identical with those of the *Bacillus coli*, with which it is usually associated. Morphologically, it is a thick, plump bacillus—non-flagellated—the growths of which on ordinary media are viscid and stringy; it is frequently found in the pus about an appendix, or in the general cavity of the abdomen, but it possesses no pathogenic properties for man, although in enormous doses it has a fatal effect on animals. When isolated in typhlitis it has no significance.

Bacillus alcaligenes (Migula, 1900).—This organism, originally described by PETREVSKY as *Bacillus faecalis alcaligenes*, is present in practically every individual, although in relatively small numbers. It is of importance chiefly from its great resemblance to

Bacillus typhosus, from which it is distinguishable only by its failure to act upon any carbohydrates, and by its intense alkali production in litmus milk. Like *Bacillus lactis aërogenes*, it is of no pathogenic importance, as its cultures are quite devoid of toxic action.

Bacillus of the Hog Cholera Group.—Organisms belonging to this group, originally described as intermediate in character between *Bacillus typhosus* and *Bacillus coli*, were early recognized by WELCH, SALMON, and SMITH in this country, and by numerous observers abroad. The number of species included in this group is very large, and all of them are possessed of marked pathogenic properties. Among them may be mentioned *Bacillus suipestifer*, or the Hog cholera bacillus, *Bacillus enteritidis* of GAERTNER, *Bacillus Breslaviensis* of GAFFKY and PAAK, *Bacillus morbificans bovis* of BASENAU, the various paracolon bacilli isolated in France and in America, and the "paratyphoids" obtained in Germany. Members of this group occur frequently in the normal intestinal tract, and are present in about 10 per cent. of all cases of appendicitis. Without extensive investigation, it is difficult to determine to which particular species any given organism should be assigned, and it is correspondingly difficult to estimate with any certainty the rôle which they take in appendicitis. Their pathogenic action, however, is very marked, and their importance is probably much greater than is generally supposed.

Bacillus aërogenes capsulatus (*Bacterium Welchii*, Migula, 1900).—This strictly anaërobic organism, originally described by WELCH and NUTTALL as the "Gas bacillus" (*Bacillus aërogenes capsulatus*), has since been recognized in a number of countries as having a wide distribution. It was described in Germany, by FRÄNKEL as *Bacillus phlegmones emphysematosae*, in England, by KLEIN as *Bacillus enteritidis sporogenes*; and the organism described as *Bacillus perfringens* by VEILLON and ZUBER is evidently the same species. The recognition of a relationship between this organism and appendicitis has already been mentioned in the consideration of Veillon and Zuber's investigations. It has been shown by Welch to have an almost universal distribution in the intestinal tract of man, as well as in that of most of the lower animals, and its constant presence in the lumen of the appendix has been demonstrated by YATES. It is, however, an organism requiring special methods of isolation in pure culture, although its morphology as a long, straight bacterium, surrounded by a capsule and retaining Gram's stain well, frequently demonstrates its presence in a mixture with other organisms. It acts as a cause of general peritonitis very rarely, and is usually considered to invade only tissues already diseased. It has, however, been found in a number of cases of appendicitis, including one associated with a severe and rapidly fatal case of general peritonitis.

CHAPTER V.

PATHOLOGY.

ACUTE APPENDICITIS.

It is only by means of observations made at operations and at autopsy, accompanied by examinations of each case in detail, that we can construct a general picture representing the pathological changes taking place in inflammations of the appendix in their beginning and development, as well as the relation between the etiology of appendicitis and its pathological anatomy. In the course of a routine examination of all specimens, many important conditions are discovered, and the pathological changes underlying the causation of an attack of acute appendicitis become apparent.

The custom, which has become general during the last few years, of early operation in appendicitis, as well as of operation *à froid*, affords the opportunity essential to studying these various lesions in their inception, their development, and their final outcome. The views expressed and the conditions described in the following pages embody results obtained from a study of all the material furnished by the gynæcological and surgical departments at the Johns Hopkins Hospital, as well as by its post-mortems, and by a large number of interesting and sometimes unique specimens obtained from different parts of the country.

The material from the gynæcological operating room consisted of 300 specimens, all of which were carefully examined both macroscopically and microscopically. The appendices removed in the surgical operating room, more than 600 in number, were all submitted to careful examination of the gross specimen, and the majority were sectioned and studied histologically. The specimens obtained at autopsies were examined, in most instances, only macroscopically.

A classification of the various forms of inflammation of the appendix is somewhat difficult, for there is no definite line dividing one from another. The following classification, however, dealing first with the change occurring in the appendix itself, then with the peritoneal involvement, and, finally, with the various wide-spread complications, seems most convenient from a pathological stand-point, while at the same time it is in accordance with the clinical varieties.

Acute appendicitis.

Subacute and chronic appendicitis.

Peritonitis.

Metastatic affections.

Acute appendicitis may be further divided into the following groups:

- (a) Catarrhal.
- (b) Diffuse.
- (c) Purulent.
- (d) Gangrenous.
- (e) Perforative.

Acute Catarrhal Appendicitis.—By catarrhal appendicitis is meant an inflammatory process affecting only the mucous lining of the appendix throughout the attack, and not involving the deeper layers. In all cases of acute appendicitis there is probably an early stage in which the reaction is limited to the mucous membrane, but in the majority of cases this is only momentary, and so speedily gives way to a general involvement of all the coats that it cannot be considered as a well-defined era in the progress of

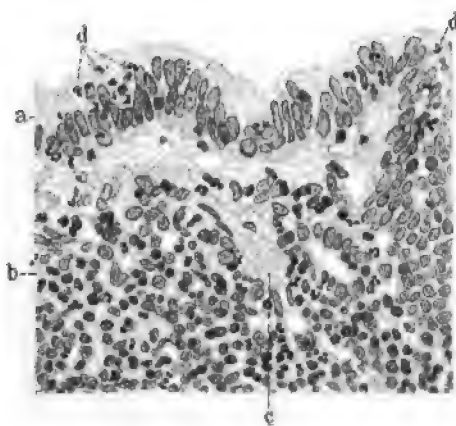


FIG. 36.—SECTION FROM THE SPECIMEN REPRESENTED IN PLATE I, FIG. 3. ACUTE CATARRHAL APPENDICITIS.

MAGNIFIED 350 TIMES.

The section shows a small portion of the surface epithelium (a) with part of a gland on the right-hand side, and the membrana propria (b) containing a dilated capillary (c). The epithelium and membrana propria are moderately infiltrated with polymorphonuclear leucocytes (d).

arborescent appearance. There is not, however, the diffuse redness of inflammatory tissue, nor is there any loss of the normal sheen of the serous covering (see Fig. 3, Plate I). On sectioning the appendix its canal is found to be patent, and, as a rule, is of uniform calibre. It contains a little mucopurulent fluid. The mucosa is swollen, oedematous, diffusely injected, and granular in appearance. The tendency to a hemorrhagic infiltration of the tissue, common to all forms of appendicitis, is not wanting in the catarrhal variety. I have never seen distinct ulceration in this class of cases, and am inclined to believe that when there are ulcerations sufficiently marked to be detected with the naked eye, more or less involvement of the deeper tissues will be found.

Histologically, the surface epithelium, which is generally intact, stains rather cloudily, and is infiltrated with leucocytes and occasional red blood-cells. Slight exfoliation of the epithelium is frequently found, but the loss is soon repaired by cells derived from the surrounding epithelium, and especially from the neighboring glands. The gland epithelium shows active proliferation and there is an abundant mucous secretion. The stroma of the mucosa is hyperæmic, œdematous, and moderately infiltrated with leucocytes (Fig. 36). The lymph nodes are swollen, the germ centres prominent, and the latter often contain a very large num-

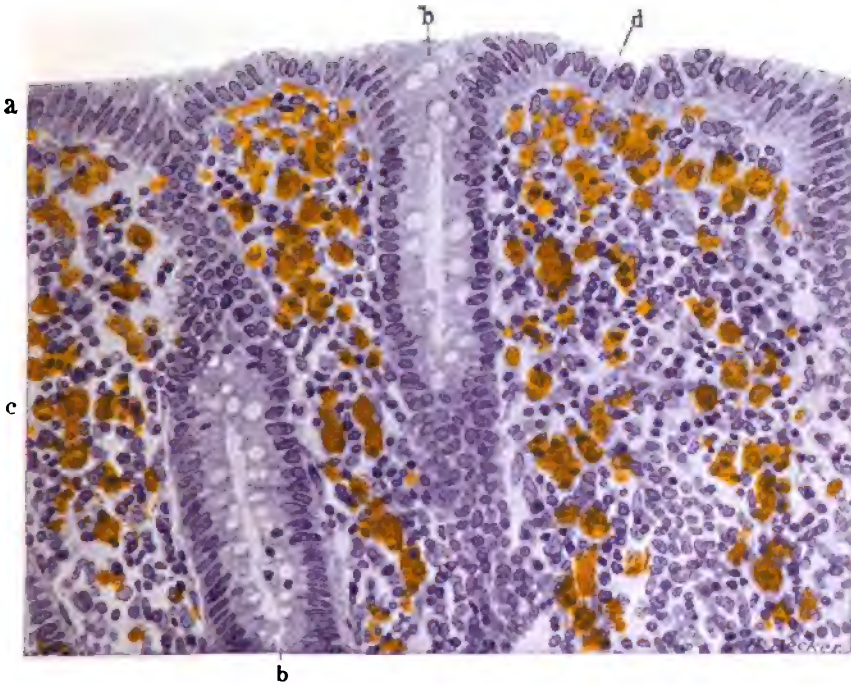


FIG. 37.—DEPOSIT OF PIGMENT IN THE MUCOSA. MAGNIFIED 400 TIMES.

a. Normal epithelium; b. glands; c. membrana propria infiltrated with a few red blood-corpuscles (d) and containing an abundant deposit of brown granular pigment, partly contained within cells. (Gyn. Path., No. 4871.)

ber of dividing nuclei. The endothelium of the capillaries and the reticular cells of the nodes are swollen, and degenerative changes are occasionally present. The lymph nodes may be free from bacteria. The submucosa and the muscular coats of the appendix are perfectly normal, and its peritoneal covering, apart from the dilatation of its blood-vessels, is unaltered.

Simple catarrhal appendicitis may undergo complete repair, and in cases which presented clinical evidence of repeated attacks, the appendix, when removed in the interval, may appear quite normal. In other cases the presence of blood pigment in the mucous membrane is the only evidence of a former pathological process (see Fig. 37); or, again, the interglandular tissue shows the presence of old granulation tissue.

Endo-appendicitis is a predisposing factor in the formation of enteroliths in the appendix, and a frequent cause of attacks of the more severe forms of appendicitis. The swelling of the mucosa tends to obstruct the lumen at the cæcal orifice, causing more or less stasis of the secretions and whatever foreign material may be in the canal. Deep crypts which form between the folds of the thickened mucous membrane furnish a favorable nidus for bacterial growths.

Acute Diffuse Appendicitis.—In the majority of cases of appendicitis which give rise to definite symptoms, the inflammatory process very early



FIG. 38.—ACUTE APPENDICITIS. SEROSA DEEP MAHOGANY COLOR, DUE TO HEMORRHAGIC INFILTRATION. ADHESIONS, PRODUCING SLIGHT KINK NEAR THE TIP. (GYN. PATH., No. 5606.)



FIG. 39.—ACUTELY INFLAMED APPENDIX. SHOWING GREATLY DILATED BLOOD-VESSELS. TIP SURROUNDED WITH LIGHT ADHESIONS (a). (SPECIMEN FROM T. S. CULLEN.)



FIG. 40.—ACUTE APPENDICITIS. THE INFLAMMATION LIMITED TO THE DISTAL HALF OF THE APPENDIX.

The contrast between the smooth pale normal mucous membrane and the thickened, hemorrhagic, inflamed portion is very striking.

extends beyond the mucosa, and there is a general involvement of all the coats. In the gross specimen, the difference between an inflammation limited to the mucosa and the diffuse process is at once evident. In diffuse inflammation, the appendix shows a notable increase in all of its dimensions, and instead of the normal, pale, flaccid organ, of about the thickness of a goose quill, it may be twice the usual length, and is often as thick as the index finger, the tip being frequently slightly clubbed. The appendix is usually tense and rigid, and exceedingly hyperæmic, the blood-vessels standing out in high relief (see Figs. 38 and 39). Its color is a diffuse bright red or dark mahogany, mottled with subperitoneal extravasations of blood, and often presenting light yellowish or greenish-yellow areas due to localized foci of suppuration or necrosis (Fig. 1, Plate III). These

necrotic areas are usually surrounded with a deeply injected zone. The canal contains a mucopurulent or purulent exudate, often mingled with blood. The mucosa is swollen, intensely injected, and hemorrhagic; its surface may be smooth, but is usually granular, and often shows irregular folds and furrows, or hyperæmic wart-like excrescences (see Fig. 40). Frequently there are more or less extensive erosions. The ulcers may be small and punched-out in appearance (Fig. 1, Plate I), but more commonly they have ragged, irregular margins. They may be single or multiple, and they vary from slight superficial abrasions to extensive losses of tissue comprising a large portion of the mucosa and involving the submucosa and muscular coats. External evidence of deep ulceration is often seen in slightly elevated, dark colored, granular areas on the surface. Erosions are produced in various ways: by the passive action of concretions and foreign bodies, by the direct action of septic material upon the surface of the mucosa, by the necrosis of an infected lymph follicle, or by the extension into the lumen of an abscess focus originating in the deeper tissues. Necrosis and ulceration are particularly liable to take place in the deep crypts in the mucosa.

In acute appendicitis ulcerations are often found when inspissated fecal material or concretions are present in the canal, and they correspond in position to the location of the concretion or are distal to it.

Purulent Appendicitis.—There is no sharp dividing line between purulent and non-purulent appendicitis, and at any moment a non-purulent process may become purulent. The nature of the inflammatory reaction is chiefly due to the virulence of the infection. A mild infection is commonly not suppurative, while a severe infection induces suppuration, unless the virulence of the infective material is so great that no migration of leucocytes occurs. On the other hand, if there is profound degeneration of the tissues depending upon some mechanical or chemical factor, the bacterial invasion may result in gangrene of the part. In suppuration there is, first, necrosis of the tissue invaded, and, second, the reaction of the tissue, producing cells which form the purulent exudate. To produce this second phenomenon a certain local reactional energy is necessary, as well as the power of resistance of the organism as a whole. It may, therefore, be said that suppuration is an evidence of the ability of the tissues to offer resistance to the invasion of the infective agent. Even where necrosis goes on and gangrene develops, the surrounding tissue still tends to react by eliminating the dead part, and suppuration ultimately appears.

One of the chief factors promoting suppuration is the existence of some anterior lesion which tends to obstruct the canal of the appendix. The acute swelling of the tissues at the outset of an attack results in complete closure of the stenosed area, and in consequence there is a damming back of the inflammatory exudate. The defective drainage, associated with the abnormal condition of the tissue, favors the development and exalts the virulence of the micro-organisms, and finally induces suppuration. The

increased tension, as the appendix becomes more and more distended, may be sufficient to overcome the obstruction, or if the tip of the appendix has become adherent to the intestine or some other hollow viscus, a fistulous opening may form at this point. In either case drainage is re-established and may be followed by resolution. In other instances, the purulent exudate is retained within the appendix, and a large pus-sac (pyo-appendix) results. Porter has described a case in which an appendix occluded at its proximal end by a fecal concretion was distended with gas and pus (pyo-pneumo-appendix). Besides such cases, in which the purulent process is general, there are others in which there are small localized foci of suppuration. It is not uncommon to find multiple miliary abscesses in acute inflammation of the appendix. These may originate in the lymph glands, as in a case described by FENGER, or in any of the tissues of the appendix wall. They are probably due to the direct action of the bacteria upon the tissue, and in some cases collections of bacteria have been demonstrated in the centres of these areas. These foci of suppuration are often found associated with erosions on the surface of the mucosa. In the fresh specimen they appear as minute, yellow, or greenish-yellow areas, which are in sharp contrast with the surrounding, intensely injected tissue.

A typical case is seen in Fig. 1, Plate III. The specimen was removed by T. S. CULLEN, eight days after the onset of an attack of acute appendicitis. The appendix, which is quite free from adhesions, is swollen and deeply congested, while at two points abscess foci are seen immediately beneath the serosa, in imminent danger of rupture. A longitudinal section of the same specimen (Fig. 41) shows complete necrosis of the mucous membrane, and the two abscess foci opening into the canal. A fine perforation also extends to the mesenteric border.

Gangrenous Appendicitis.—This condition is essentially characterized by the death and putrefaction of the tissues, and is due to the action of microbes upon tissue which has been subject to some influence inducing partial or complete degeneration (see Fig. 42). Gangrene is related to suppuration by numerous transitions, the differentiation being sometimes scarcely definable. While it may be doubted if any micro-organisms can affect perfectly healthy tissue, there are some which, attacking tissue slightly altered, have the power to cause its death and subsequent putrefaction. The greater number of organisms, however, can only act upon tissue which is profoundly altered. The most important factors inducing gangrene are those which act by obstructing the circulation, and so producing a local ischæmia. The interruption to the blood current may occur in one of the small arteries which supplies only a limited portion of the appendix; or the main artery may be involved; or, in some instances, both the vein and artery, in which case the entire appendix becomes gangrenous. It is not uncommon to find the appendix represented by a dark greenish-black mass, which has separated from its cæcal attachment and lies free in the abdominal cavity. The obstruction to the circulation may be caused by thrombo-angitis, twists, angulations, and compressions by

adhesions or by a hernial ring. Localized areas of gangrene may also be produced by the pressure of concretions. Mechanical factors may, in themselves, be sufficient to cause complete obstruction, as, for instance, when the appendix becomes strangulated by means of adhesions, etc. More commonly, however, a partial obstruction occasioned by them is rendered complete by sudden swelling of the appendix, taking place at the outset of an acute inflammatory attack. It is only in this way that a concretion is able to produce gangrene of the portion of the wall with which it is in contact. The pressure of the concretion, added to the acute oedema which accompanies the early inflammatory changes, compresses the tissues, and produces local ischæmia with subsequent gangrene.



FIG. 41.—ACUTE APPENDICITIS. APPENDIX LINED WITH NECROTIC MATERIAL. MAGNIFIED 1.5 TIMES.

At *a* and *a'* are abscess foci, and at *a''* a pin-hole perforation; *c* indicates the hyperæmic, oedematous mesentery. There is no stricture and no concretion. (Case of T. S. Cullen.)



FIG. 42.—APPENDIX ALMOST TOTALLY GANGRENOUS AND SURFACE PARTLY COVERED WITH LARGE PLAQUES OF GREENISH-YELLOW LYMPH. NO EVIDENCE OF STRICTURE NOR CONCRETIONS. (SURG. PATH., No. 3232.)

R. MORRIS ascribes the frequent occurrence of gangrene of the appendix to the tension caused by the unyielding muscular coats when compressed by the acute swelling of the mucosa and submucous layers.

When gangrene is the result of interference with the circulation by means of strictures, twists, or adhesions, the entire appendix, or the portion beyond the obstruction, is involved; and, as mentioned above, a similar result follows thrombosis of the main blood-vessels. Thrombo-arteritis affecting one of the branches may be followed by a localized area of necrosis. Most frequently the tip of the appendix is affected (see Figs. 1 and 2, Plate II), but it is not unusual to find several distinct areas of gangrene both in the proximal and the distal portions of the appendix.

Such a case is shown in Fig. 3, Plate II, where the surface of the appendix is mottled bright red and green, and at no point, from the base to the tip, is the entire circumference free from gangrene. In some instances, only the proximal end becomes gangrenous, in which case the necrosis may be determined by the presence of a concretion; or, the gangrene may be of the annular variety, and probably due to thrombosis of the separate arterial branch which sometimes supplies this region. In such a case there may be a complete separation of the fairly normal appendix from its cæcal attachment. In other cases, again, the outer coats may entirely slough off, leaving an intact although necrotic mucous membrane. Such a case is



FIG. 43.—TOTAL GANGRENE OF THE INTERIOR OF THE APPENDIX ASSOCIATED WITH THE PRESENCE OF FECAL MASSES. (SPECIMEN FROM J. M. T. FINNEY.)

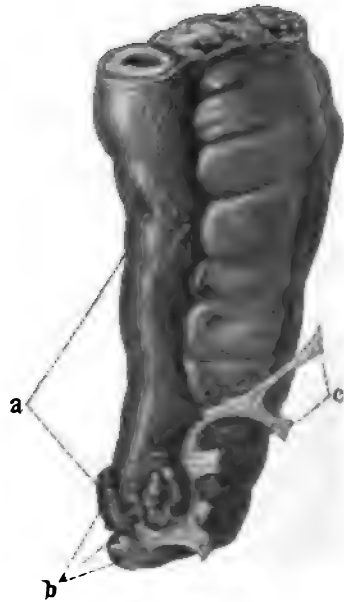


FIG. 44.—ACUTE APPENDICITIS WITH THICKENED HEMORRHAGIC MESAPPENDIX.

The distal two-thirds of the appendix (a) is hemorrhagic, and also the small masses of fat (b). Adhesions are found at c. (Gyn. Path., No. 6252.)

described by FOWLER. The rôle of bacteria in the production of tissue necrosis is an important one, and in cases where gangrene of the appendix is partly due to mechanical influences, the heightened virulence of the contained bacteria, in the presence of the lessened vitality of the tissue, undoubtedly promotes the destructive process. The action of bacterial poison may cause gangrene even in the absence of obstruction to the circulation, the degenerative process being then most pronounced in the interior, where the infective substance is in direct contact with the tissues. It is particularly the putrefactive organisms contained in decomposing

fecal material which produce this condition. An excellent example is seen in the case illustrated in Fig. 43. Here the mucosa, as a whole, is gangrenous, but apart from the perforation at the tip the gangrenous process has not involved the deeper layers, which show an intense, purulent, inflammatory reaction.

The mesappendix in acute inflammation becomes greatly thickened, owing to the dilatation of the blood-vessels, and the infiltration of the lax areolar tissue with a serous and cellular exudate. The tissue also becomes exceedingly friable, so that the ligature, although placed with the utmost care, often tears directly through it. The color is usually reddish, often a dark red, from the presence of hemorrhage (see Fig. 44). In the presence of old adhesions or twists it is evident that acute oedema of the mesappendix could readily induce partial or complete occlusion of the large blood-vessels; also, in the case of advanced arteriosclerosis of the main blood-vessel, the circulation may be greatly impeded, and even completely obstructed by the pressure of the infiltrated tissue.

HISTOLOGY OF ACUTE DIFFUSE APPENDICITIS.—The whole appendix shows a greater or less degree of inflammatory reaction. At the outset, there is a general congestion and oedema, especially affecting the mucous, submucous, and peritoneal layers. The mucosa shows, usually, some degeneration of the surface epithelium, and, as a rule, of the gland epithelium. In some instances these changes are insignificant, consisting in a slight swelling and cloudiness of the cells; while in others a large portion of the epithelium is destroyed. This is sometimes due to effusion of blood, which, lifting up the epithelium from the underlying tissue, deprives it of its nutriment; leucocytes, chiefly polymorphonuclear, are found in variable numbers throughout the epithelium and in the exudate upon the surface. The glands, besides showing degenerative changes in the epithelium, are greatly compressed, and sometimes destroyed by the acute swelling of the interstitial tissue. The changes in the lymph nodes are often marked, the blood capillaries are congested, and the endothelial elements swollen and proliferating; leucocytes are present in variable numbers, and there are often large phagocytes containing cellular detritus, usually fragments of leucocytes; occasionally the centre of the follicle is degenerated, and it may even open upon the surface of the mucous membrane. The interglandular tissue, as a rule, shows the most marked changes. It is greatly congested, and permeated with a serous effusion, extravasated blood, and a more or less abundant cellular exudate. Polymorphonuclear neutrophils usually predominate, but there is also an increase in the number of eosinophiles, small round and plasma cells. In some instances eosinophiles make up a large proportion of the infiltrating cells. Abrasions and ulcerations are usually found, under the microscope, where the inflammation is at all severe, although they may not be apparent to the naked eye. They occur most frequently in the crypts between the mucous folds (Figs. 45 and 46). The surface of the erosion is covered with mucus and fibrin intermingled with cellular detritus; underneath there is the usual acute

granulation tissue. In the periphery of the eroded area there are often areas of canalized fibrin, and vascular changes are observable extending some distance away.

The submucosa in acute diffuse appendicitis usually shows a severe grade of inflammation. The blood-vessels are engorged, the tissue is highly œdematous, and there is a general cellular infiltration consisting of polymorphonuclear, small round, and plasma cells, the first type greatly predominating. The connective-tissue cells are swollen and actively proliferating. When ulceration occurs, the submucosa is almost invariably

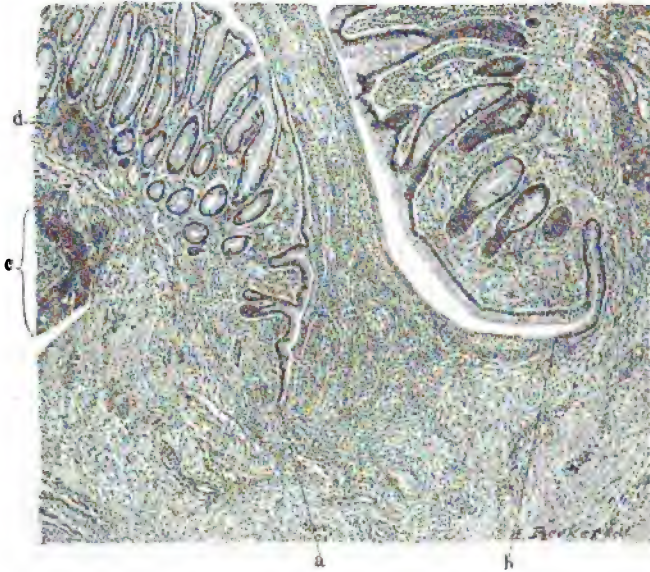


FIG. 45.—ACUTE DIFFUSE APPENDICITIS. MAGNIFIED 40 TIMES.

An erosion (a-b) in the crypt, between two folds of mucous membrane. The mucosa on either side of the ulcer is œdematous and infiltrated, its surface being bathed with a purulent exudate. At the base of the mucosa there is a small abscess focus (d); c indicates a lymph follicle. (Specimen from L. M. Hektoen.)

involved. Miliary abscesses originating in lymph nodes usually involve this layer, and very often abscess foci develop primarily in this region.

The circular and longitudinal muscular coats share to a variable extent in the inflammatory reaction. In many instances, the only evidence of reaction is found along the course of the blood- and lymph-vessels in the hiatuses of the musculature. There is usually considerable leucocytic infiltration of these areas, and connective-tissue proliferation. A purulent inflammation confined to the mucous and submucous layers may extend outward by way of these structures, and cause an acute peritoneal reaction, or even a perforation, without involvement of the musculature. However, as a rule, in suppurative appendicitis there is also more or less infiltration along the course of the vessels which run parallel to the muscle bundles, and in some instances rows of leucocytes separate the individual muscle fibres. The interstitial tissue of the muscular coats is œdematous,

and the connective-tissue cells are swollen and proliferating; the muscle cells, on the other hand, show more or less marked degenerative changes.

The peritoneum and the subperitoneal fibrous tissue undergo important changes. Often while the musculature, and even the submucosa, show no perceptible change, a marked inflammatory reaction is found in the serous membrane. At the outset of the attack there is extreme congestion of the blood-vessels, which is almost immediately accompanied by an intense œdema. Soon there is an abundant leucocytic infiltration, proliferation of the endothelial cells, and a high degree of connective-tissue

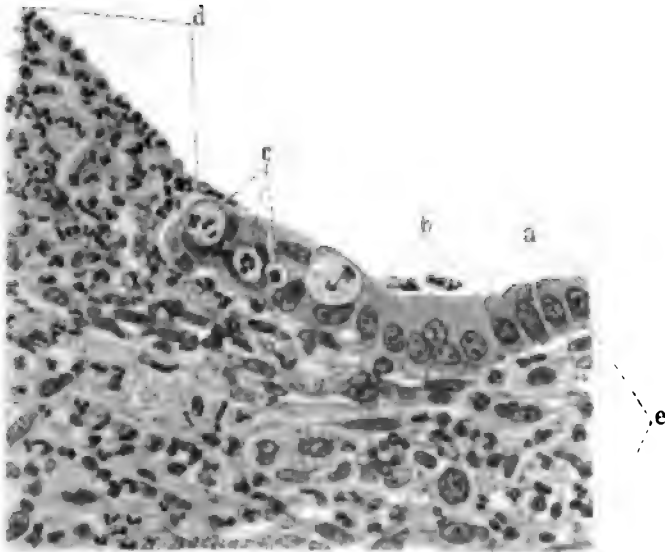


FIG. 46.—Higher magnification of the margin of the ulcer seen in the preceding figure. The epithelium at *a* is normal; at *b* the cells are swollen and cloudy, and from here to the edge of the ulcer the epithelium shows more pronounced degenerative changes and is infiltrated with leucocytes (*c*). The surface of the ulcer (*d*) consists of a mass of fibrous leucocytes and red blood-cells. More deeply the tissue is composed of connective tissue with abundant large oval and fusiform cells, dilated capillaries, and a diffuse infiltration of leucocytes and red blood-cells. Magnified 400 times.

proliferation. Vascular changes are frequently observable in this region. Interstitial hemorrhages usually occur and are often very extensive.

The changes in the mesappendix consist chiefly in œdema and dilatation of blood-vessels. There is usually a slight leucocytic infiltration surrounding the vessels and extravasations of blood are commonly met with. In some instances there is a general purulent infiltration of the adipose tissue, and necrosis of part or the whole of the mesentery is not rare. The vascular changes in the muscular and serous coats and in the mesentery are generally of secondary development, and there is seldom definite evidence of pre-existing disease of the larger vessels.

Purulent thrombo-arteritis and thrombophlebitis occur in some cases. The vessels most frequently affected are those of the submucosa in the region of an erosion, or the comparatively large vessels coursing between

the external muscular coat and the peritoneum. In exceptional instances there are acute changes, acute angeitis or thrombo-angeitis, in the large vessels contained in the mesappendix.

The lymph channels of the appendix and its mesentery in acute inflammation are often found distended with lymph-corpuscles, and various grades of lymphangitis may be observable.

Perforative Appendicitis.—Perforation may take place in any variety of acute appendicitis, and in any stage of the attack. In some instances the first symptoms are due to the occurrence of perforation, while in other cases the acute attack has apparently subsided when perforation suddenly takes place. The rupture may be of pin-hole size or there may be a wide ragged aperture through which a large concretion can escape. In the appendix represented in Fig. 47, almost the entire circumference is involved in the large perforation which occupies the centre of a gangrenous area surrounded by a zone of intense hyperæmia. This appendix was removed by T. S. CULLEN thirty-six hours after the onset of the attack. There may also be two or more perforations. Very often, in the laboratory, unsuspected perforations are detected, which have been sealed by adhesions, most frequently by the adherent omentum. The factors concerned in the production of a rupture are various; it may follow the extension of an erosion to the peritoneal surface, the degeneration of the tissue due to purulent infiltration, or it may be the result of thrombosis or embolism. A tensely distended empyema often terminates in rupture of the appendix walls, and it is particularly in such cases, where a large amount of highly virulent material is emptied into the abdominal cavity, that the most fatal forms of peritonitis result. SCHRUMPF describes a case of spontaneous rupture of a tensely distended appendix in which the contents were sterile and the walls showed no active inflammatory reaction. Pin-hole perforations may result from the continuance of a purulent process along a muscular hiatus, and therefore are usually situated along the mesenteric border or at the tip of the appendix.

One of the most important causes of rupture is the necrosis of the tissue, induced by the presence of concretions, the deleterious effect of which is brought into play only by the swelling of the tissue in acute inflammation. The association of concretions with perforative appendicitis is so often observed that an etiological relationship cannot be questioned, and in many cases the evidence of cause and effect may be clearly demonstrated. In some instances a small rupture is found directly over the most prominent portion of the concretion (see Fig. 47), in others an impending rupture is found in a corresponding area, or the concretion may cause an obstruction of the canal and the perforation occurs in the part beyond it. The direct agency of pointed and irregular foreign bodies in causing a perforation of the appendix will be considered in another section.

Where rupture follows an erosion the procedure is gradual, the various layers giving way as the degenerative process extends outward. In the case of gangrene following embolism rupture of the different coats is prob-

ably in most instances practically simultaneous. In some specimens the inner coats have given way, only the peritoneal covering remaining. In the appendix shown in Fig. 48, operation thirty-six hours after the onset, an extensive clean-cut perforation of all the outer layers has occurred, leaving only a pouch of mucous membrane which, although gangrenous, has not ruptured. The favorite location of the perforation is at or near the tip of the appendix, but it is not uncommon to find a perforation directly at the base, or at some intermediate point. A perforation at the base may involve the neighboring portion of the cæcum and produce a wide opening through which the intestinal contents escape. The extension by continuity of the inflammatory disease of the appendix to the surrounding portion of the cæcum has occasionally resulted in a perforating ulcer of the cæcum. The propagation of the disease to the cæcum may be owing to thrombophlebitis or to the direct action of bacteria upon the diseased tissues. Such cases may be wrongly interpreted as instances of primary disease of the caecum. As explained before, a perforation of the proximal end of the appendix may result in its complete separation from the cæcum. It has then been found floating free in an abscess cavity, or has become attached to some other structure, receiving nutriment through newly formed vessels by means of adhesions. In a case of G. W. CRILE'S (*personal communication*), operated on after several attacks of appendicitis, the distal 3 cm. of the appendix was found closely adherent to the surrounding structures, 9 cm. from the normal point of attachment. The proximal end of the fragment was well rounded off and completely closed. The lumen contained a small amount of fluid. Similar cases have been described by R. MORRIS, BARTH, and others. ELTING found the amputated appendix in a hernial sac.



FIG. 47. — PERFORATIVE APPENDICITIS. (SPECIMEN FROM T. S. CULLEN.)

Acute appendicitis may undergo repair, but a complete *restitutio ad integrum* is probably exceedingly rare. As a rule, various deformities remain, such as angulations, twists, and, what are perhaps most important, irregularities in the canal, consisting of scars and strictures (see Residual conditions). Obliterative arteritis is common in the small vessels of the submucosa, and in rare instances obliterative thrombo-arteritis is found in the large vessels of the peritoneum and muscular coats, and may even involve the main appendical vessel. This point will be further considered in connection with other residual conditions following acute and chronic affections.

SUBACUTE AND CHRONIC APPENDICITIS.

In this group are included subacute and chronic inflammatory conditions of the appendix, and also that varied class of cases which I have designated residual appendicitis, in which the essential lesions are the effects of an anterior inflammation rather than an active process.

Very often, after an attack of acute appendicitis, it may be after the first, or after several preceding attacks, changes remain which under the continued influence of an infective agent lead to a chronic condition. But chronic appendicitis is not necessarily preceded by an acute process. It



FIG. 48.—ACUTE APPENDICITIS.

The distal two-thirds distended and intensely injected. On the anterior surface a gangrenous pouch of mucous membrane, covering a concretion, protrudes through a rupture in the outer layers. A similar protrusion of mucous membrane is seen on the convex margin. There are three concretions in the appendix. (Surg. Path., No. 3173.)

may have an insidious onset and occur independently of any acute attack. Very many cases are discovered accidentally in the course of operations undertaken for the relief of other abdominal affections in patients who have never suffered from any symptoms referable to the disease. Moreover, from the pathological findings of many specimens removed in what was supposed to be a first attack of appendicitis, it would appear that very often acute appendicitis is preceded by a primary chronic inflammation. In fact, some writers express the opinion that acute appendicitis never arises *de novo*, but is always dependent upon the deleterious effect of an anterior chronic process, excepting, of course, such cases as are the direct result of injury by foreign bodies, strangulation in a hernial ring, etc. RIEDEL believes that acute appendicitis has always an insidious onset, one of the most important predisposing causes being a chronic primary disease, "appendicitis granulosa." Chronic inflammation of the appendix is essentially a hypertrophic process and produces a characteristic thickening and rigidity of its walls. In rare instances the inflammatory reaction seems to be confined to the mucous membrane, but, as a rule, all the coats are

more or less affected. Macroscopically the appendix is found to be thicker than normal, but may be either increased or diminished in length. It is quite common to find the appendix very thick and short, often not more than three or four centimetres long and a centimetre or more in diameter. In a case reported by WEIR, the densely adherent inflamed appendix was only half an inch long, and nearly half an inch thick. There had been several sharp attacks of inflammation, and after removal of the appendix recovery was prompt and permanent. In some instances there is a moderate increase in length.

The whole organ may be uniformly thickened to the size of the little finger or larger; very often it is club-shaped, the proximal end being almost normal or even reduced in thickness, while the tip is enlarged. In other instances, the outer half or more is hypertrophied, while again there may be irregular thickenings separated by normal or constricted portions.

The mesappendix may be unaltered, but it is often thickened and indurated, and is apt to be more or less shortened. The color of the appendix is usually reddish, and the superficial blood-vessels are very tortuous and prominent, while ecchymotic areas are not uncommon (see Fig. 2, Plate I). There are also often characteristic anæmic areas, usually at the tip, significant of an obliterative process. This is well shown in Fig. 49,

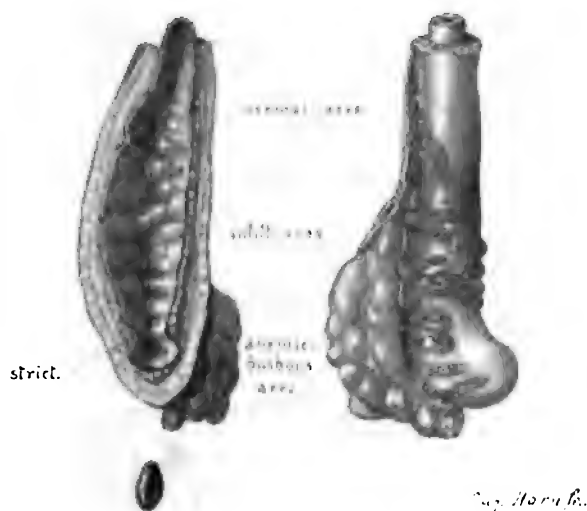


FIG. 49.—CHRONIC APPENDICITIS WITH ANÆMIC BULBOUS TIP CONTAINING A SOFT FECAL MASS. (GYN. PATH., No. 5640.)

where the whitish knob-like tip is sharply contrasted with the brightly injected median portion.

The most striking feature in chronic appendicitis is the appearance of extreme rigidity. The appendix may project directly out from the cæcum, independently of adhesions or any other external influence, the mesentery being often tightly stretched. Again, with a greatly shortened mesentery, the appendix may be sharply bent upon itself, or it may project in the form of a spiral. The characteristic rigidity is particularly evident to the touch. Upon rolling the appendix between the fingers and compressing it, instead of the normal, easily collapsible walls, there is found a dense unyielding tube, the sides of which cannot be pressed together. Sometimes the thickened appendix may be readily palpated through the abdominal wall and rolled under the fingers. Section shows a general thickening of the

tissues, but more especially of the submucous and serous membranes. The lumen, instead of assuming the stellate form of the normal appendical canal, retains a circular outline and, except in strictured areas, remains widely open; a condition which, associated with enfeebled muscular power, favors the reception and retention of foreign material; sometimes, owing to cicatricial contraction of the chronically inflamed appendix mucosa, the canal is much narrowed. The canal presents various irregularities produced by the cicatrization of ulcers or hypertrophy of the walls. If the hypertrophy or constriction of the appendix walls results in complete occlusion of the canal at one point while the remainder is still patulous, or if a partial stenosis is rendered complete by means of kinks or twists,



FIG. 50.—CHRONIC APPENDICITIS.

The mucous membrane is thickened, rugous, and at *a* forms a distinct polyp. (Specimen from I. R. Trimble.)

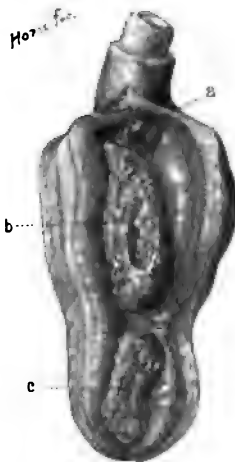


FIG. 51.—CHRONIC APPENDICITIS.

The appendical walls are thickened and cedematous, the most pronounced changes appearing in the submucosa. The canal is strictured at one point and contains two soft concretions (*b* and *c*). At *a* there is a small hæmatoma of the mucous membrane. (Surg. Path., No. 4358.)

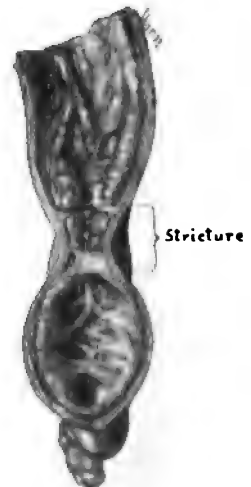


FIG. 52.—CHRONIC APPENDICITIS, WITH COMPLETE STRICTURE IN THE MIDDLE, AND THE MUCOUS MEMBRANE ENTIRELY REPLACED BY SCAR TISSUE. (Surg. Path., No. 4755.)

the part beyond the obstruction may become distended with a clear mucous or serous fluid or with a turbid purulent exudate producing a hydro- or pyo-appendix. The mucosa is usually thickened, but in some instances appears to be thinner than normal and may even be indistinguishable from the underlying submucous tissue. Its surface may be smooth, sometimes having a glazed appearance, or it may be granular, or wart-like. In exceptional instances mucous polypi develop as shown in Fig. 50. The color of the mucosa is a bright red, usually mottled with petechial hemorrhages. A characteristic case of chronic appendicitis is given in Fig. 51, which shows the greatly hypertrophied, cedematous walls, the circular canal at the cut end, and, farther out, a stricture. The mucous membrane is smooth and devoid of the usual folds. At one point a small

DESCRIPTION OF PLATE III.

Fig. 1. — *Strophomena* sp. 1. (a) Dorsal view, (b) ventral view, (c) lateral view, (d) detail of the hinge area, (e) detail of the muscle scar area, (f) detail of the brachidium. Scale bar = 1 mm.

DESCRIPTION OF PLATE III.

FIG. 1.—Acute appendicitis, eight days. The appendix irregularly distended and hyperæmic. At *b* and *c* foci of suppuration are visible.

FIG. 2.—Chronic appendicitis. The whole appendix is thickened, rigid and exceedingly œdematous. The tip is occupied by a dense tumor-like mass which consists of the hypertrophied œdematous submucosa covered with a whitish deposit containing calcareous material. A small papillary elevation near the tip is also covered with this whitish deposit. The remaining surface is smooth, the mucosa atrophic.

FIG. 3.—Enteroliths in the appendix, one distinctly faceted and resembling a gall-stone.

FIG. 4.—Mild subacute appendicitis. Soft fecal concretions. The mucous lining of the distal portion (*a*) is swollen and hemorrhagic.



Fig. 1



Fig. 2



Fig. 3



Fig. 4

hæmatoma is elevated above the surrounding surface. There are two soft concretions in the canal. Very frequently only a portion of the mucosa, the distal half or two-thirds, is involved in an inflammatory process, the remainder presenting the normal, pale, smooth, glistening appearance; or, again, some portion, or almost the whole mucous membrane may be replaced by chronic granulation tissue showing various stages of organization and cicatrization. A calcareous deposit is sometimes found on the surface and in the tissue.

The appendix shown in Fig. 52 was removed after the fourth and most severe attack of inflammation. It was lightly adherent to the cæcum, brightly injected, and presented a slight constriction about its middle.

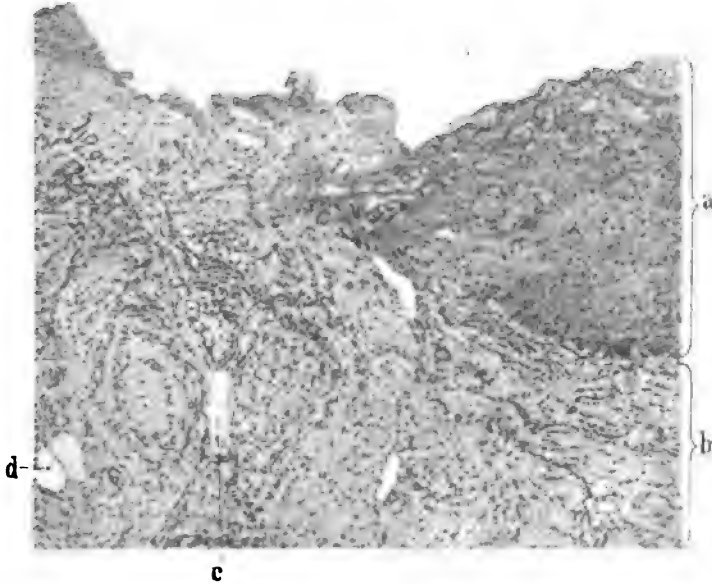


FIG. 53.—A SECTION FROM THE PRECEDING SPECIMEN. MAGNIFIED 40 TIMES.

On the left the surface shows extensive coagulative necrosis; on the right there is a thick layer of a mucoid substance (a) containing traces of fibrous tissue and vessels, a few leucocytes, and cellular detritus. b is the deeper portion of the submucosa; c, blood-vessels; and d, fat-cells.

On section the canal was found to be completely obliterated at two points, about 5 mm. apart, the intervening space containing mucus. The whole inner surface was granular, or rugous, and crossed by bands of dense scar tissue. The canal contained a little mucus. Microscopic examination (see Fig. 53) revealed complete destruction of the mucous membrane, not a trace of epithelium or lymph nodes remaining. The surface in most places showed coagulative necrosis associated with a mucoid degeneration of the tissue. That the mucus was not simply a deposit upon the surface was shown by the remnants of blood-vessels and connective-tissue strands which were traceable in it. The submucosa was fibrous and oedematous, likewise the muscular coats. There was a diffuse infiltration of the inner layers, chiefly with plasma cells. Here and there a deposit of yellowish, granular pigment was seen.

The most marked changes are often found in the submucosa, which appears as a thick, dense, fibrous band, sometimes forming more than half of the entire thickness of the walls of the appendix, the increase being chiefly at the expense of the mucous layer. The muscular coats may preserve their usual relation to the other tissues or may appear thicker or thinner than normal. The peritoneum is usually thickened, and is exceedingly vascular. In some instances the different layers are indistinguishable from one another, and the whole greatly thickened wall of the appendix appears to consist of a homogeneous, oedematous fibrous tissue which is sometimes strikingly suggestive of a new growth.

HISTOLOGY OF CHRONIC DIFFUSE APPENDICITIS.—The essential condition found here is a fibrous tissue transformation affecting to a greater or

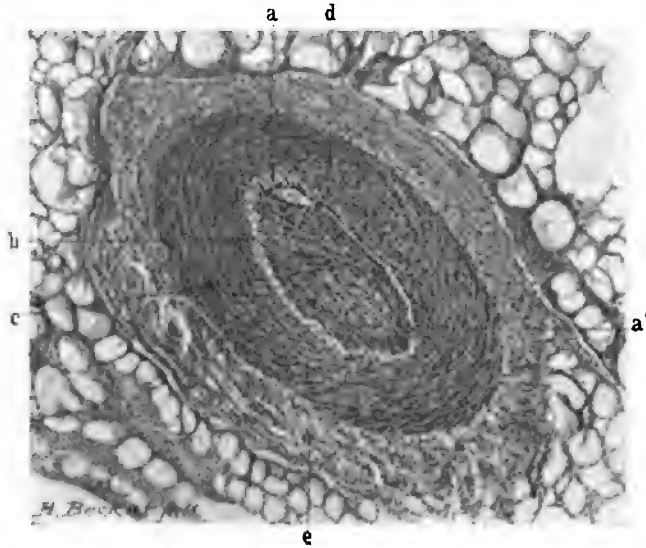


FIG. 54.—**OBLITERATIVE ENDARTERITIS IN THE MESAPPENDIX.** MAGNIFIED 90 TIMES.

a-a', The vessel lumen; *b*, the external elastic layer of the intima; *c*, thickened portion of the intima; *d*, tunica media; *e*, tunica externa.

less degree all the layers of the appendix wall. The general fibrous change is accompanied by sclerosis and obliterative changes in the blood-vessels. The mucous membrane is usually oedematous; the interglandular tissue is vascular, more fibrous than normal, and contains an increased number of lymphoid and plasma cells. Red blood-cells are often found, and in many cases there is a deposit of brownish granular pigment of hæmatogenous origin. Hemorrhage into the tissue and beneath the epithelium may, according to RIEDEL, precipitate a sudden acute attack of inflammation, by injuring the tissue. The solitary follicles may be greatly swollen, forming a continuous zone of lymphoid tissue; or, again, they are to a great extent, or wholly, replaced by fibrous tissue. The surface epithelium is usually flattened and the glands are shallow and compressed by the infiltrated interglandular tissue. A few glands may be cystic. In

some instances the only trace of the mucous membrane consists of a layer of flattened epithelium, resting directly upon a layer of dense cicatricial tissue. The submucous, muscular, and subperitoneal layers are altered to a varying degree. As a rule, the most marked fibrous tissue proliferation is found in the submucosa, which may be thickened out of all proportion to the other layers. The small blood-vessels of this region have greatly thickened walls, and not infrequently are almost completely obliterated. Small round lymphoid, and plasma cells may be very abundant, the latter usually predominating. A specimen, recently sent me for examination, had been pronounced small round cell sarcoma on account of the dense masses of plasma cells found in the submucosa.

In the muscular coats the connective-tissue hyperplasia occurs at the expense of the muscle fibres. The subperitoneal layer takes an active part in the general fibrous tissue increase, and usually shows sclerotic changes in the smaller blood-vessels. As a rule, the larger vessels of the peritoneal coat are fairly normal, and the main appendical vessel, with its tributaries, in the mesappendix is almost constantly so. In rare instances the vessel walls are slightly sclerotic, but advanced obliterative changes I have found in only one case (see Fig. 54), which was furnished me by STEENSLAND of Syracuse, New York.

Chronic Ulcerative and Purulent Appendicitis.—Chronic diffuse inflammation renders the appendix peculiarly susceptible to further infections, which may result in repeated acute attacks, or in a chronic suppurative process. As pointed out by LENZMANN, there may be a concurrence of two factors which expose the appendix to the danger of further injury: the ready reception of foreign material from the cæcum, and the more or less pronounced disability of the appendix to free itself from this material. A lurking place for fecal particles with their infective and putrefactive contents is thus created, and the abundant bacterial development of the cæcal region, extending by direct propagation to the appendix, is there further influenced by the condition of stasis produced by the rigidity of the tissues and the loss of muscular power. The result of these conditions is that, ultimately, the bacterial activity causes more or less tissue necrosis and excites a suppurative or non-suppurative reaction in the neighboring tissues. The necrotic areas are usually in direct relation with the infective material, and may be limited to the mucous membrane, or may extend deeper, sometimes involving the peritoneal coat. Sometimes also there may be circumscribed ulcers having infiltrated, irregular margins, the base being covered with necrotic material; or there may be a diffuse suppurative process. If the canal becomes obliterated at any point, a purulent exudate accumulates in the appendix, and a tensely distended pus-sac results. The size of the mass depends partly upon the location of the obstruction, whether close to the cæcal orifice or at some distant point, and partly upon the nature of the infection. The slow accumulation of the purulent exudate, and the gradual distention in the case of a chronic pyo-appendix, are accompanied by a hyperplastic tissue growth in the walls

of the appendix, which become greatly thickened, in some instances being from 5 to 10 mm. thick. In such a case the normal constituents of the appendix walls are entirely replaced by chronic granulation tissue, rich in cellular elements. The inner surface is covered with necrotic tissue and fibrin. The mass rarely has a diameter of more than 2 to 3 cm., but it may attain enormous dimensions, as in a specimen sent me by G. MULLER (see Fig. 55).

In some instances the mass is freely movable and without adhesions, in others the omentum may be attached, but most frequently it is fixed by adhesions to the abdominal wall or other neighboring structures.

As in the case of acute purulent appendicitis, perforation may result



FIG. 55.—EMPYEMA OF THE APPENDIX.

At the caecal end the greatly thickened walls completely occlude the canal, and the rest of the appendix is distended with pus. The whole interior is lined with ragged necrotic material. The mucous and sub-mucous layers are almost totally destroyed, but in places are represented by islands of thickened, degenerated tissue.



FIG. 56.—CHRONIC SUPPURATIVE APPENDICITIS WITH OBLITERATED LUMEN AT *a*, AND BEYOND THIS A PUS-SAC WHICH HAS RUPTURED (*b*).

The collapsed condition of the walls of this portion shows that there has been considerable distention. The mucosa here is irregular and at a point opposite the concretion (*c*) has been destroyed.

from the extension of the necrosis to the peritoneal surface (see Fig. 56). But in chronic suppuration, more frequently than in acute conditions, the productive inflammatory reaction forms a protective barrier which limits the distribution of the infection. Moreover, whereas in acute pyo-appendix the virulence of the infective agents is exalted, in chronic suppuration the mild infection may be limited, or even destroyed by the reaction on the part of the tissues. Resolution may follow the rupture and drainage

of the empyema into the intestine or other hollow viscus, or the contents may become absorbed, and the cavity finally obliterated by granulation tissue.

RESIDUAL APPENDICITIS.

This term includes the various deformities of the appendix which may follow acute or chronic inflammation after the active disease has subsided. The results may be hypertrophy or atrophy of the appendix, stricture or obliteration of its lumen, cystic dilatation, diverticula or angulations or twists due to adhesions or cicatricial contractions in the appendix wall. These conditions have been already referred to, but are more conveniently considered as a distinct class. They are of importance not only on account of their etiological relation to recurrent acute infection, but as the usual source of the clinical conditions described by LENZMANN and by EWALD as *appendicitis larvata*. As has already been explained, acute or chronic appendicitis exceedingly rarely results in a *restitutio ad integrum*. In the mildest cases there is more or less connective-tissue hyperplasia, and as a consequence a certain amount of rigidity and enfeebled muscular power persists. In the

healing and repair of erosions, newly-formed connective tissue replaces the destroyed area, and like all cicatricial tissue, tends to contract, resulting in strictures, angulations, or occlusion of a portion of the canal. ABBÉ, who has devoted much attention to this condition and is strongly impressed with its pathogenic importance, has prepared an

excellent series of specimens which show its various grades as well as the number of stenoses which may follow appendicitis. A typical example of multiple stenosis associated with stercoral concretions, furnished by RUNYON, is given in Fig. 57. In this case one or more attacks of mild inflammation, possibly confined to the inner layers, have been productive of several areas of complete and partial stenosis, without at any time having given rise to attacks of pain or tenderness in the abdomen.

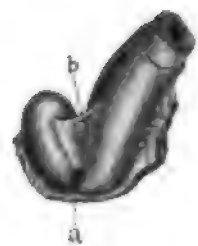


FIG. 58. — KINK AND STRICTURE PRODUCED BY ADHESIONS IN A CASE OF CHRONIC APPENDICITIS.

a, Kink, with separation of distal from proximal portion of the appendix; b, adhesion. The distal portion is obliterated. (Gyn. Path., No. 5218.)



FIG. 57. — MULTIPLE STRICTURE IN THE APPENDIX.

The appendix was removed during the course of an operation for myoma. General destruction of the mucosa is followed by total obliteration of the canal. If the canal is only partially stenosed, other factors, such as kinking or the compression by adhesions, may make the obstruction complete. In the appendix shown in Fig. 58 the kink produced by the dense band of adhesions has resulted in the separation of the distal from the proximal

end of the appendix, the two portions being connected by the mesentery and a band of fibrous tissue.

Retention Cysts of the Appendix.—If a portion of the canal distal to the obstruction remains patent, the normal secretion, having no outlet, accumulates in it and a retention cyst is produced. The contents of the cyst



FIG. 59.—CYSTIC APPENDIX WITH THE PROXIMAL END (a) PROTRUDING INTO THE CÆCUM. Several tags of adhesions are seen on the surface of the cyst. (Sent by E. E. Montgomery from the Museum of Jefferson Medical College.)

are at first composed of the normal mucous secretion of the appendical mucosa, or of a mucopurulent, sometimes sanguineous fluid; but later, probably owing to pressure atrophy of the mucosa and consequent loss of function, the mucous secretion ceases, and the fluid becomes serous or watery in character. If the occlusion has occurred close to the cæcal at-

tachment of the appendix, the cyst appears to arise directly from the cæcum. In the case shown in Fig. 59 stenosis had probably taken place directly at Gerlach's valve and did not involve the canal beyond this point. The thin membrane which obstructed the canal at the valve became gradually

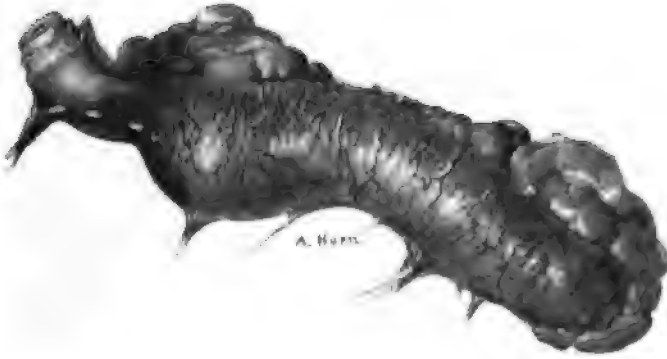


FIG. 60.—CYSTIC DISTENSION OF THE LOWER THREE-FOURTHS OF THE APPENDIX DUE TO STRICTURE OF THE CANAL. The proximal end is pervious. The surface of the cyst covered with adhesions and markedly injected. (Gyn. Path., No. 5718.)

distended by the pressure of the fluid within the appendix so that finally the cyst became partly intracæcal. Other cases have been reported in which the cyst had developed almost wholly within the cæcum. If the



FIG. 61.—THE APPENDIX AS SEEN, *in situ*, NOVEMBER, 1897. SHOWING A SINGLE CYST AND OBLITERATED, WITHERED DISTAL EXTREMITY.

obstruction is at a more distant point, the cyst appears to be pedunculated, being attached to the cæcum by the normal proximal portion of the appendix (see Fig. 60). Again, only the tip may be cystic, or the middle of the appendix may be distended while the proximal and distal portions

are obliterated. The canal may be occluded at two or more points, and the intervening portions may become cystic. In some instances secondary cysts develop in partly occluded glands.

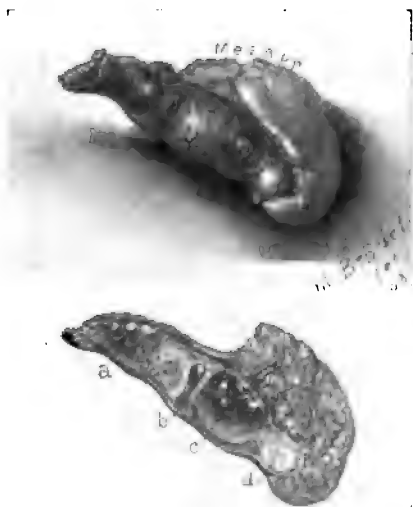


FIG. 62. — THE SAME APPENDIX (SEE FIG. 61).
REMOVED OCTOBER, 1903.

The obliterated distal portion has become much shortened. *c* probably represents the original cyst, and *a* and *b* are of later development. Cavities *b* and *c* communicate with each other. (Gyn. Path., No. 6996.)

a smooth surface, while the latter is covered with adhesions and has a long pedicle. Histologically, a general connective-tissue proliferation is apparent, with a corresponding loss of the normal elements of the appendix walls. The whole picture is that of a mild, chronic, inflammatory reaction associated with pressure atrophy of the tissues. The mucosa, as a rule, is represented by a single layer of low columnar or cuboidal epithelium resting directly upon a layer of fibrous tissue. Glands have usually disappeared. An occasional small, flattened lymph node may be seen. In many cases the muscular coats are almost entirely replaced by fibrous tissue, but in some instances the muscle bundles are fairly well preserved. As a rule, there is a slight diffuse round-cell infiltration (see Fig. 64).

Diverticula of the Appendix.—Diverticula of the appendix do not differ from those found elsewhere in the alimentary canal. They may occur when cystic distention of the appendix follows occlusion of part of the canal, particularly when the muscular coats are weakened by an antecedent

Cysts of the appendix, as a rule, are cylindrical in form and vary in size from about the thickness of a lead-pencil to from one to three centimetres in diameter. In exceptional instances very large masses develop. One described by SONNENBURG was an enormous pear-shaped cyst, 14 cm. in length and 21 cm. in its greatest circumference. VIRCHOW described a case in which the appendix was as large as a fist. The walls of the cystic appendix are attenuated and transparent. The peritoneal surface often presents a few adhesions, but may be perfectly smooth. The inner surface is usually smooth and glistening. Figs. 63 and 60 are characteristic examples of the cystic appendix.

The former is situated directly upon the



FIG. 63.—CYSTIC APPENDIX.
(GYN. PATH., NO. 2170.)

inflammatory process; they may also be produced by external traction by means of adhesions, etc. The diverticula may be single or multiple. The majority develop between the mesenteric folds or at the tip of the appendix, but they may be situated in any part of the appendical wall. J. HERB describes a case in which a globular cyst, 23 cm. in circumference, projected from the middle of the appendix on the side opposite the mesenteric border, while in one of RIBBERT'S cases the diverticula formed a grape-like cluster of cysts. Diverticula consist of hernia-like protrusions of the mucous membrane beneath the peritoneum, and the cavity of the cyst

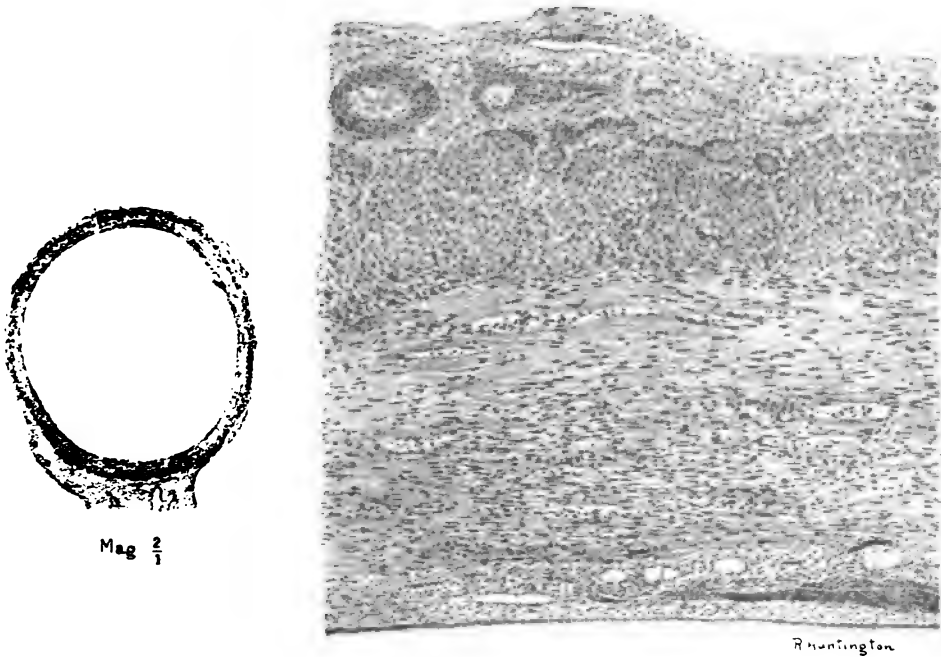


FIG. 64.—SECTION FROM THE PRECEDING CASE (FIG. 63) OF CYSTIC APPENDIX.

The small picture on the left shows the dilated lumen and thinned-out walls. The area between the two dotted lines is seen, highly magnified, in the picture on the right side. The mucous membrane is represented by a layer of flattened epithelium resting upon a layer of fibrous tissue. A small flattened lymph node is seen near the edge of the picture. There is a general round-cell infiltration of all the coats.

usually communicates with the distended lumen of the appendix by means of a smooth circular or oval orifice. Histologically the thin walls are composed of connective tissue lined with a layer of flattened epithelium. A few compressed glands may be found and occasional muscle fibres may extend a short distance from the base over the walls of the cyst.

Obliteration of the Appendix.—Considerable attention has been recently directed to obliterative changes in the appendix. RIBBERT, WÖLFLE, and ZUCKERKANDL, from the careful examination of a large number of cases, all arrived at the conclusion that obliterative changes in the appendix are not the result of an inflammatory process, but an involution process in a functionless organ. CRUEILHIER, BIERHOFF, FITZ, SENN, and others

believe that obliterative changes have a pathological origin. TCHACALOFF, in 19 cases of partial or total obliteration, found in all distinct evidence of a pathological process. RIEDEL advances the view that obliteration of the appendix is due to a chronic inflammation of the appendix, "appendicitis granulosa," which is followed by the formation of cicatricial tissue and the gradual narrowing and final obliteration of the lumen. RIBBERT in a later article modified his original view by stating that a chronic toxic irritation produced by the bacteria contained in the appendix may induce a mild inflammatory process which leads to the obliteration of the canal.

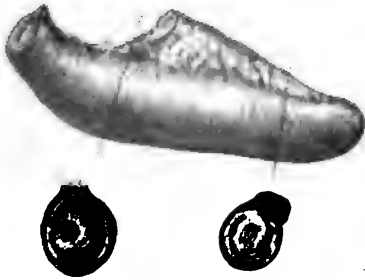
My investigations have dealt chiefly with specimens removed at operation, and only to a limited extent with autopsy material, as, unfortunately, the macroscopic appearance of the appendix alone was noted in the autopsy protocols, and the specimens were not preserved.

In the gynæcological service at the Johns Hopkins Hospital it has for some years been the rule to examine the appendix, if accessible, whenever the abdomen is opened for any reason, and if it presents any deviation from the normal, however slight, it is removed, provided always that there is no special bar to the operation. Thus, it has been the custom to remove the appendix if thicker or firmer than normal, even if the rigidity is very slight, or merely involves the tip. On this account it has been possible to examine a large number of specimens showing obliteration, and sufficient evidence has been obtained from these cases to warrant some conclusions regarding the origin of many cases of partial and complete obliteration of the appendix, although no definite conclusion can be reached regarding the relative frequency of its occurrence. The opportunity to inspect and remove the appendix occurs most frequently in the course of gynæcological operations; in the general surgical department the approximately normal appendix is less frequently removed. This probably accounts for the fact that in the material from the gynæcological operating room I have found 21 cases of complete obliteration of the canal of the appendix, but only two such cases among the specimens from the surgical department, although in the latter twice the number of appendices had been removed. Partial occlusion of the canal occurred in about equal proportions in the two series of cases. In considering the etiology and pathology of obliteration of the appendix, I have chiefly studied the specimens from the gynæcological department.

Out of 300 specimens, 45 were found to present some degree of obliteration, varying in extent from a small portion of the tip to the occlusion of the entire canal. Under this group I have not included cases of appendix with greatly thickened walls and narrowed but patent lumen, as these are manifestly of inflammatory origin; nor do I include simple strictures, which have clearly resulted from cicatrization of erosions.

The 45 cases comprise 21 in which the lumen is entirely obliterated, and 24 in which it is partly obliterated. In the specimens showing partial obliteration, the extent of the occluded portion varied from about 1 cm. at the tip, to a half or three-fourths of the length of the organ. In one

instance only, a few millimetres of the proximal end was provided with a central lumen. With a few exceptions the obliteration extended from the tip inward, the occluded part forming a solid cord. In one case, previously described, the proximal and distal thirds were obliterated, while the middle third was cystic. In 8 cases the proximal end was obliterated and the part beyond cystic, the occluded portions in these cases varying from a few millimetres to several centimetres; in one case only the distal third remained patent. These cases of cystic changes in the appendix have already been considered. The obliterated appendix may be thickened, firm, and cylindrical (see Fig. 65), or it may be reduced to a thin fibrous cord or flattened band (see Fig. 66). In cases of partial obliteration, also, the affected area may be either hypertrophied or atrophied. If only the tip is involved the appendix may have a clubbed appearance, or may dwindle away to a fibrous cord. When the median portion is obliterated the organ



2 cm.

FIG. 65. — HYPERTROPHIED APPENDIX WITH OBLITERATED LUMEN. (NATURAL SIZE.)

There were a few slight adhesions in the vicinity of the appendix. (Gyn. Path., No. 3859.)



FIG. 66. — ATROPHIED APPENDIX WITH OBLITERATED LUMEN. (NATURAL SIZE.)

Fine adhesions over the middle portion. (Gyn. Path., No. 2884.)

may be divided into two distinct portions connected by a narrow fibrous cord (Fig. 67). A withered appendix, when retrocæcal and extraperitoneal, or covered with adhesions, may readily be overlooked and the case regarded as an instance of absence of the appendix.

In 36 of my cases the surface of the appendix presented evidence of adhesions. The adhesions were dense in some cases, but more often they were very delicate. The color of the appendix was always distinctly paler than normal, although occasionally the superficial blood-vessels were dilated. When the obliteration involved only a part of the appendix, it could at once be recognized by the color as compared with the rest of the organ.

Cross-sections of the obliterated appendix examined by the naked eye usually revealed two distinct layers, namely, an outer layer consisting of the musculature, and a central layer consisting of fibrous tissue. The relative proportion of these layers is quite variable. As a rule, the muscular coat is of about normal thickness, but it is sometimes greatly thickened, or it may be atrophied and scarcely distinguishable. Similarly, the cen-

tral fibrous tissue may be abundant, or may have undergone considerable shrinkage. To a great extent this variability depends upon the stage of the affection, but not entirely, as some very thick appendices show a very thin muscle layer; while in others of the same diameter there may be a broad band of muscle; and, again, a withered appendix may have a relatively well developed muscle coat, or may be almost wholly fibrous tissue.

The microscopic picture of the obliterated appendix is a varied one, the characteristic appearance depending partly upon the stage, but chiefly upon the character of the pathological process. A cross-section of a thickened, obliterated appendix may show any of the following conditions in the centre:

1. A centre of cellular fibrous tissue containing remnants of lymph follicles or glands, and sometimes both. Occasionally a microscopic triangular or irregular slit represents the former canal. This has no special



FIG. 67.—CHRONIC APPENDICITIS WITH STRICTURE.

The distal portion is completely obliterated, but the proximal end is pervious and shows an active inflammatory process. (Surg. Path., No. 9068.)

cell lining, and as the tissue contracts will probably disappear. The remnants of lymph follicles and glands which are present indicate an early stage of the obliterative process, and they also will finally disappear. The submucosa is thickened, fibrous, and contains more or less fat, usually only a moderate amount, while numerous blood-vessels radiate to the centre. There is often a slight round cell infiltration of the submucosa.

2. The centre is fibrous and contains no remnants of mucosa. The tissue may be fairly cellular and contain numerous lymphoid elements, but no well-formed follicles. The surrounding tissue is usually dense, fibrous, and may contain very little or a moderate amount of fat.

3. The centre consists of fibrous tissue, poor in connective-tissue cells, and free from lymphoid elements. The surrounding tissue often contains a large amount of fat. In one of my cases the thickened obliterated appendix showed a rather thin musculature surrounding a mass of adipose tissue with a fine central strand of fibrous tissue, formed by the intersecting fibres of the framework of the adipose tissue. This appendix was also surrounded by a mass of fat. In the majority of my sections I have found a deposit of brown granular pigment in the obliterated areas.

The muscular coats, as a rule, are of about the usual thickness. Either layer, or both, may be thicker than normal, or attenuated. The increase in thickness may be due to hyperplasia of muscle, but is often due to connective-tissue proliferation, while the muscle itself is diminished in amount.

The peritoneal coat, where free from adhesions, is usually normal, but may be thickened. A high degree of sclerosis of the blood-vessels is generally visible in all the different layers, but is especially marked in the submucosa.

The withered appendix rarely shows any trace of the mucous membrane. The central fibrous tissue is dense, and its outer zone, which represents the submucosa, contains little or no fat. The muscular coats may be well preserved, but usually there is fibrous tissue proliferation at the expense of muscle tissue. Sometimes the muscle has practically disap-



FIG. 68.—SECTION FROM THE SPECIMEN SHOWN IN FIG. 66.

The centre consists of dense fibrous tissue containing a moderate amount of fat. The circular muscular coat is atrophic, the longitudinal layer well developed. The walls of the blood-vessels in the mesappendix are somewhat sclerotic. (Gyn. Path., No. 2884.)

peared. In one of my cases all that remained was a narrow band along the mesenteric border. In the section represented in Fig. 68 the muscular coats are relatively thick and well preserved. The central fibrous tissue is dense and contains a small amount of fat.

In both the hypertrophic and atrophic forms of obliteration I have usually found a complete absence of lesions affecting the nerve elements. In most cases the nerves, owing to the paucity of cells in the surrounding tissue, appear to be unusually prominent.

In a partly obliterated appendix, the canal of the patent portion may be of normal size and shape and the mucous lining little if at all altered. Very often, however, the canal is circular and the walls more or less rigid. As in diffuse chronic inflammation, the surface of the mucosa, instead of presenting the usual folds, is smooth and even; the epithelium is often a little flattened; the interglandular tissue shows some degree of fibrous change.

In some cases a gradual transition from the normal patulous condition to the completely obliterated portion may be traced. In one of my cases, where the appendix was 4 cm. long and 6 mm. in diameter, the lumen was



FIG. 69. — OBLITERATION OF THE LOWER TWO-THIRDS OF THE APPENDIX.

The upper third distended with pus and perforated. Removed during the twenty-sixth attack.

obliterated except for a few millimetres of the proximal end. Beginning at the cæcal orifice the canal was found to have become gradually narrower, the mucosa atrophic, and the glands gradually diminished in number until finally the mucosa was replaced by fibrous tissue which completely occluded the canal. In other instances the transition, instead of being gradual, is abrupt. The canal may be entirely normal to a certain point, then suddenly cease. In the case shown in Fig. 67 the appendix has a lumen of normal calibre to a point where it is suddenly reduced to a narrow impervious fibrous cord. The distal portion, although of the usual size, is also obliterated. The appendix was removed at operation after the fifth severe attack of inflammation. At the time of operation the constricted middle portion was bound down by dense adhesions.

In cases where the obliteration is limited to a small area near the centre of the appendix, the proximal end may be perfectly normal, the distal portion cystic, and the obliterated area not more than one or two millimetres in extent.

Such a condition can only be explained by the adhesion of opposite sides, as a consequence of erosion.

The majority of my specimens showed indubitable evidence of an antecedent inflammatory process, chiefly in the presence of adhesions, which were found in about 60 per cent. of the cases. The presence of pigmentary changes in some pointed to a former pathological process, while in others, again, an active inflammation still existed often in the absence of adhesions. The same regularity of structure was often observed in the appendices which showed distinct evidence of an inflammatory process as in other specimens where an inflammatory origin was not apparent.

The examination of numerous appendices removed shortly after the subsidence of an acute inflammatory attack demonstrates most convincingly the method of procedure in the production of obliteration. These

specimens still show more or less of an active inflammatory reaction, chiefly evidenced by a leucocytic infiltration. In some, pronounced hypertrophy of the walls has taken place while the lumen is reduced to almost microscopic size; other specimens show cicatrization of erosions, producing irregular constrictions. Fig. 52 (see p. 70) represents an appendix removed during an attack of inflammation. In this case the canal is still patent, but the entire mucosa has been replaced by fibrous tissue which is beginning to contract, and it is probable that in this case complete obliteration would have resulted.

A recent case of acute appendicitis affords a further proof of the inflammatory nature of obliteration in some cases; sections from the distal half of the specimen show the surface of the mucosa completely destroyed and the opposite sides adherent to one another by a fibrous exudate, which shows beginning organization. Sections from the proximal end of the same specimen show here and there small areas of flattened surface epithelium, while the remaining surface consisted of granulation tissue. The walls generally are infiltrated with leucocytes. The result in this case would certainly have been, ultimately, an obliterated distal end and an obliterated or stenosed proximal portion. Total obliteration of the canal insures perfect immunity from further attacks, but if any portion remains pervious, the disposition to repeated attacks increases with each succeeding one. The specimen shown in Fig. 69, furnished by C. BECK, was removed from a woman sixty-eight years old who had had twenty-six attacks of appendicitis, and demonstrates the danger still lurking in the diseased organ.

CONCRETIONS.

The rôle of concretions and foreign bodies in the production of inflammation of the appendix will be discussed in another section, but the nature and origin of concretions are more appropriately considered in connection with the pathology of the appendix.

It has been noted above that the normal appendix often contains fluid fecal material which readily enters from the cæcum, and is as readily expressed back into it. Fecal material exhibiting various degrees of inspissation is also frequently found in the appendix, and sometimes forms rather firm cylindrical masses which conform to the shape of the canal in which they are contained. While these masses may appear somewhat dense, they are quite friable, and consist almost wholly of undigested food and other foreign material, together with a small amount of mucus, and, occasionally, a few leucocytes and epithelial cells. True enteroliths are much rarer, and are found in only a small percentage of cases. These are exceedingly dense, and, unlike the softer masses, are often rounded in outline and cause a distinct bulging of the appendix walls. Apart from their pathogenesis, the chief points of interest in regard to concretions are their structure and the factors concerned in their development. In former times it was the generally accepted view that concretions lodged in the appendix were pre-formed in some other part of the intestinal canal,

or in the gall-bladder, and later worked their way or were forced into the appendix. A glance at the anatomical structure of the appendix shows that in the majority of cases it would be impossible for an enterolith, not one-quarter the size of many actually found there, to pass through such a narrow channel. The difficulty is further enhanced by the angle of attachment of the appendix, which causes almost complete closure at the site of Gerlach's valve. I



FIG. 70.—APPENDIX CONTAINING SPHERICAL CONCRETION.
(SURG. NO., 3248.)

would not go to the extent of some writers who deny the possibility of gall-stones or enteroliths being forced into the appendix, but I believe such accidents are extremely rare. Where the fetal type of appendix persists, foreign bodies, including gall-stones, could readily enter the wide appendico-cæcal orifice. Reverse peristaltic contractions of the colon may possibly aid in forcing the mass from the cæcum into the appendix. The fact, however, that bodies exactly resembling gall-stones are found in appendices in which it is manifestly certain that the calculus must have been formed *in situ*, and that these bodies on chemical and microscopical examination have shown the presence of a nucleus of organized matter surrounded with layers of inorganic salts, makes me hesitate to accept any such cases as genuine examples of

gall-stones. The presence of cholesterin does not necessarily indicate a gall-bladder origin, although large amounts of cholesterin are not often found in enteroliths. Nor does a faceted surface imply that the stone was formed in the gall-bladder, as such are occasionally seen in the appendix.

A convincing proof as to the formation of the appendical concretion *in situ*, rather than in some other portion of the intestine, is found in the characteristic architectural arrangements of the enterolith itself, and in the relation which its chief constituents bear to the appendix walls.

Macroscopical Appearance.—The concretions, as a rule, are ovoid or spherical and have a dense, more or less smooth polished

surface (Fig. 70). The color is a dark brown. It is common to find the dark surface partly covered with a grayish-white deposit of lime salts, while section through the centre shows that the interior is lighter in color and more friable than the surface. There is usually a nucleus consisting of a fragment of foreign material, and, surrounding this, concentric layers of a substance largely composed of lime salts.

Histological Examination.—The histological examination shows that the most important factor in the formation of the calculus is the mucus secreted by the glands of the mucous membrane. The mucus, which is deposited in layers around the central nucleus, becomes desiccated, and the lime salts are deposited secondarily. Frequently, fragments of epithelium, a few leucocytes and altered blood are found in different layers. RIBBERT noted that in favorable specimens stained with Weigert's fibrin stain, the outer layer of mucus may be seen to be directly continuous with the contents of the glands of Lieberkühn. In one case, besides the two large enteroliths in the canal of the appendix, I found three smaller bodies embedded in the mucous membranes, which had evidently developed within gland lumina.

Method of Development.—Normally, the fecal particles which enter the appendix are returned to the cæcum by means of the peristaltic contractions of the appendix walls. If, however, the muscular power is enfeebled in any way, or if—through the shape or size of the fecal mass, or for any other reason, as, for example, the presence of a kink or stricture—an impediment is offered to the progress of the mass toward the cæcum, it is retained within the appendix and undergoes various changes. The fluid portion is gradually absorbed and the mass becomes more or less inspissated. While the drying process is taking place, there is a constant factor at work, which is largely responsible for the increase in the size and density of the mass, namely, bacterial activity. The effort of the appendix to expel the foreign material is attended with more or less congestion and œdema, and thus a favorable opportunity is provided for the activities of the micro-organisms contained in the mass itself. These organisms, which are often of a low degree of virulence, excite a mild catarrhal inflammatory reaction, chiefly marked by an increased secretion of mucus. There is also a slight leucocytic infiltration and some exfoliation of the surface epithelium. The congestion of the mucosa is often associated with slight interstitial hemorrhages, indicated by the deposit of pigment in the interglandular tissue, and by the presence of altered blood in the concretion.

The increased mucus secretion is the chief factor in the formation of calculus. The mucus is deposited upon the surface of the dried fecal particle or other nucleus, and as it is deposited becomes desiccated, and later mixed with lime salts. The influence of the continued bacterial activity in promoting a separation of calcareous material from the mucus secretion, has been demonstrated by the experiments of GALIPE (cited by Labarthe). This writer, placing some saliva in a flask, added micro-organ-

isms which began to develop there, and soon after crystals of calcium carbonate were deposited upon the saliva. A chronic catarrhal cholecystitis associated with the presence of micro-organisms of low virulence is generally conceded to be of chief importance in the production of gall-stones, and there is evidence showing that a similar condition is equally important in the formation of enteroliths in the appendix.

The concretion gradually increases in size as the layers of altered mucus and lime salts are added, while, *pari passu*, the walls of the appendix expand and usually become somewhat attenuated, until finally the glands disappear and the secretion of mucus ceases.

The spherical form of many calculi found in the appendix is supposed by some writers to be possible only when the mass has formed in a free space, and on this account the concretions are believed to enter the ap-



FIG. 71.—MUCOUS MEMBRANE, SHOWING IMPRESSION OF ENTEROLITH. MAGNIFIED 25 TIMES.

The mouth of a gland (a-b) is widely dilated by a projecting point of the concretion. (Gyn Path., No. 2041.)

pendix from the cæcum, but, as we have seen, a microscopic examination shows that the mucus which goes to form the calculus is derived from the glands of the mucous lining of the appendix. A particularly instructive case in this connection is seen in one of my own series. In this instance the appendix, which had given rise to no clinical signs, was removed during the course of an operation for myoma of the uterus. It was free, but was excised on account of the large calculi which it contained. The appendix is 15 cm. long, its middle third is distended with a spherical concretion 12 mm. in diameter, and from here to the tip a cylindrical concretion 12 by 6 mm. fills the canal. The spherical mass has a smooth, polished surface, rather closely beset with spike-like projections which are fitted into corresponding depressions in the mucosa (Fig. 71). The surface of the second mass is smooth. There are also two or three hard, smooth bodies from 1 to 2 mm. in size, which are wholly embedded in the mucous membrane. (A similar case in which there were concretions embedded in the mucosa has been described by SCHRUMPF.)

Microscopic examination shows a normal mucous membrane excepting where the projections noted above are lodged. Here the glands are pressed apart and the surface epithelium, though intact, is flattened (see Fig. 71). Apparently these projecting points were formed in the crypts.

CHAPTER VI.

PATHOLOGY (CONTINUED).

PERITONITIS.

THE paramount importance of peritoneal complications of inflammatory diseases in the right iliac fossa has long been recognized, and in early times, when the cæcum was regarded as the general source of the inflammatory affections of the region, the terms *perityphlitis* and *paratyphlitis* were used to designate the extension of the infection to the peritoneum and neighboring tissues. That the appendix is the source of practically all cases of peritonitis limited to the caecal region, and is the chief source of generalized peritonitis, is now universally acknowledged. Some well-known writers still hold that perforation of the cæcum with ensuing peritonitis may result from the rupture of a deep-seated stercoral ulcer; but the majority of writers of the present day, including DEAYER, LENZMANN, and SAHLI, are inclined to doubt its occurrence, or to regard it as very exceptional.

The presence of a perforation in the cæcum is sometimes regarded as a proof of the occurrence of perforative stercoral typhlitis, the observers not bearing in mind the fact recognized by BURNE in 1839 that the rupture into the cæcum of an abscess originating from without is a common event. In cases where the appendix itself is but slightly altered, it is sometimes difficult to determine in which direction the rupture has taken place. As a rule, however, the cæcum presents definite evidence of the external origin of the lesion, in that its outer coats show an extensive defect with necrotic margin surrounded by inflammatory tissue; the opening in the mucosa is smaller and the surrounding mucous membrane smooth and practically normal. It cannot be denied, however, that in exceptional instances a primary non-specific typhlitis may occur, and may give rise to an infection of the surrounding tissues and to general peritonitis. REISINGER, out of 350 cases of perityphlitis operated on at the Krankenhaus in Mainz, found two in which the cæcum only was diseased. In one of these cases it was filled with hard fecal masses and was perforated in two places. Autopsy revealed no cause for this condition.

CARL BECK describes in detail a case originally operated upon for appendicitis, in which partial gangrene of the cæcum was revealed, and during the course of a laparotomy performed later the appendix was found intact.

SONNENBURG describes a case of circumscribed inflammatory disease, primary in the cæcal walls, not due to a specific infection, and apparently

not associated with a stricture. This writer suggests the possibility of there having been a hernia of this portion of the bowel into a peritoneal pocket. In one instance related by RENVERS, cited by Sonnenburg, a pericæcal abscess followed a perforation caused by the attrition of a fecal concretion the size of a walnut, which was lodged in a pocket in the cæcal wall. This case, as well as a second, in which a concretion had formed with a gall-stone as a nucleus, belongs rather to the relatively common class of cases in which perforation of the cæcum is due to injury by a foreign body. OSLER states that he has twice seen perforation of cæcal ulcers. In only one (Reisinger) of the recorded cases was there any mention of fecal impaction in the cæcum. JAYLE advances the view that in old age the cæcum rather than the appendix is the frequent source of right iliac inflammation. This view, however, lacks clinical and post-mortem proof. The most convincing proof of the great rarity of this condition is found in the fact that at autopsy *in vivo*, and on the post-mortem table, simple primary perforative typhlitis is observed. That there are instances of typhlitis which go on to ulceration, and may lead to rupture with subsequent abscess formation or diffuse peritonitis, is very true; but these are practically all cases of secondary disease of the cæcum due to stricture, etc., or else are cases of specific inflammatory disease, such as may affect any portion of the alimentary canal. Tuberculosis, typhoid fever, actinomycosis, and amoebic dysentery, all give rise to inflammation attended with ulceration, which may proceed to perforation with all its unfortunate sequelæ. Tubercular infection is especially prone to become localized in the cæcal region, and instances of perforation of tubercular ulcers are not rare.

In the majority of all cases of appendicitis there is more or less involvement of the peritoneum. In chronic appendicitis there are usually adhesions; in acute inflammation all grades of peritonitis are seen, from the mildest, in which the serosa of the appendix alone is reddened and turbid, but without appreciable exudate, to the most intense general reaction, characterized by an abundant purulent exudate filling all parts of the peritoneal cavity and walled off partially, or not at all, by friable adhesions into pockets. Between these extremes all grades of the affection may exist. It is not to be supposed, however, that the various forms of peritonitis merely represent different stages in the same process, and that, unless interrupted by operation or limited by the resistance of the organism, each individual case would proceed through all stages. On the contrary, there are some cases which run their course to a lethal termination, and show only a fibrinous deposit throughout, or there may be no visible peritoneal reaction; while in others there is from the outset a copious purulent exudate. As a rule, however, an early reaction accompanied by a serofibrinous exudate precedes the suppurative process. According to ADAMI, an abundant serous exudate occurs with toxic and other non-bacterial irritants and has a flushing-out action, whereas bacterial invasion excites a purulent exudation which serves to dilute the infective material.

Animal experimentation has shown that after the injection into the peritoneal cavity of a large amount of infected material of a low grade of virulence, the bacteria become absorbed and the animal lives, while the same amount of material of a high virulence causes death in from ten to twenty hours, with almost no evidence of peritoneal reaction. The organism is overwhelmed by the rapid absorption of a large amount of toxic material. A small amount of unusually virulent material causes death from toxæmia with or without bacteriæmia; a greater dilution of the same, in consequence of slower absorption, is more favorable. Likewise, other things being equal, a large serous or purulent exudate is favorable. The outpouring of an abundant exudate is in general a conservative process, as it serves not only to dilute the infective material, but increased amounts of opsonins are brought to bear upon the invading bacteria and prepare them for ingestion and absorption by the phagocytes, while large numbers of phagocytes are present to aid in disposing of the infective organisms and of the degenerate tissues resulting from their action.

The amount of opsonins and other ferment-like bodies present in the exudate depends partly upon the virulence and amount of the infection and partly upon the local and general resistance of the organism. The invasion of very virulent micro-organisms may inhibit all local protective reaction even with a normal opsonic index; while, on the other hand, if opsonins are not present in the normal body-fluid, phagocytosis does not take place.

In the slight local reaction accompanying mild attacks of appendicitis, and in more serious infections during the early peritoneal reaction characterized by a slight serofibrinous exudate, the peritonitis is now generally believed to be due to the diffusible toxins produced by the bacteria and is not due to the invasion of bacteria into the peritoneum. It is to this "toxic peritonitis" that a localization of an infection is chiefly due.

The varieties of peritoneal reaction are differentiated according to the amount and character of the exudate, and are as follows:

- Acute fibrinous peritonitis.
- Acute serofibrinous peritonitis.
- Acute fibrinopurulent peritonitis.
- Acute purulent peritonitis.
- Acute dry or septic peritonitis.

In regard to its protective or reparative effects, the inflammatory reaction may be characterized as deficient, adequate, or excessive, according as the infection continues to spread, is adequately controlled, or, the infection being controlled, an excessive or harmful tissue production continues.

The extension of the inflammatory reaction in appendicitis beyond the organ itself, may be conveniently considered under the following divisions:

1. Circumscribed inflammation of the peritoneum and other structures in the immediate neighborhood of the appendix; and intra- and extra-

peritoneal abscesses by direct propagation, including pelvic abscesses, subphrenic abscesses, empyema of the pleural cavity, abscess in the muscles of the abdomen and back.

2. Diffuse and generalized peritonitis.
3. Extension of infection by way of the blood vascular system: thrombosis, purulent phlebitis, embolism, liver and lung abscess.
4. Lymphangitis, septicæmia.

Localized Peritonitis.—As stated above, the peritoneal investment of the appendix, which is an integral part of the organ itself, is involved in practically all cases of appendicitis, excepting instances of mild catarrhal affections. In most instances the process extends beyond this point, and involves to a greater or less degree the surrounding structures. When operating during the first twenty-four or thirty-six hours of an acute attack, it is common to find a slight excess of serous fluid in the right iliac fossa, with a little fibrin deposited upon the appendix and upon the contiguous visceral or parietal peritoneum forming an easily separated adhesion, while the surrounding peritoneum is reddened and may have partly lost its normal lustre; or, even when no exudate is visible, on lifting up the appendix it may seem to be slightly adherent to the adjacent peritoneum and a somewhat viscid condition of the surface is discernible. This slight local reaction, as has been said, is not due to bacterial invasion, but is induced by the action of the diffusible toxins of the infective agent. Cultures from the affected area of peritoneum, as a rule, are sterile in these cases, and no organisms are found in cover-slip preparations. In mild affections of the appendix the peritoneal reaction may not progress beyond this stage, and resolution soon follows. In other instances, however, this condition only marks the initial stage of the peritoneal involvement and is succeeded by the more intense reaction which accompanies the invasion of bacteria. When the infective material is of a low degree of virulence, the reaction of the peritoneum is characterized by a more or less abundant fibrinous or serofibrinous exudate, forming somewhat dense, but at the outset very friable adhesions. The appendix is often entirely buried in the thick mass of friable, fibrinous material, which glues together all the adjoining structures. This inflammatory mass, including the appendix, is often very oedematous, and hemorrhages from the greatly dilated blood-vessels frequently occur. In some instances the exudate is so abundant and increases so rapidly that an abscess is suspected. At an early date the invading bacteria are destroyed and beginning organization is found, which, unless some untoward accident occurs, proceeds rapidly, so that in a short time the mass becomes greatly diminished in size, and finally all that remain are the adhesions binding down the more or less thickened appendix. On examining such a specimen after removal, it is not uncommon to find that a deep-seated ulcer or area of necrosis has caused a virtual perforation of the appendix wall, but that the thick adventitious layer has acted as a barrier to the further progress of the infection. Very frequently only a small portion of the serosa of the appendix and a corre-

spondingly limited area of the adjacent peritoneum are affected, while the rest of the appendix is practically normal. The distal end is most often involved, probably on account of more defective drainage. When the first effort of nature to limit the progress of the disease is not successful, the point of greatest danger, where rupture is most imminent, fortunately tends to attach itself to a neighboring structure and thus avert the danger of a general peritoneal infection. The area of impending perforation sometimes becomes adherent to some portion of the intestinal canal, and if drainage is established, a spontaneous cure of the attack may be obtained. It is less fortunate for the individual when the appendix drains into some other hollow viscus, as the bladder, the ureter, the gall-bladder, or the pleural cavity. One of the most striking examples of nature's ability to limit disease with the most excellent results, is seen in the often observed tendency of the omentum to gravitate to the danger point. A very small area may become attached, as in the case shown in Fig. 72, or the tip, a half, or even the entire appendix may be rolled up in the omentum (see Fig. 73). As this tissue becomes more or less infiltrated and œdematous, a large oval mass the size of a fist may be formed. This is often quite movable, and on account of the density, size, and mobility of the mass, the physical signs in such a case are often suggestive of a neoplasm. When the mass is adherent abscess formation is closely simulated.

In examining many specimens consisting of the appendix embedded in the omentum, or with a portion of the omentum attached to it, I have found that as a rule there is a distinct defect in the wall of the appendix at one or more points, and that these areas have been sealed over by the omentum, the destroyed area being replaced by inflammatory products. In the case shown in Fig. 73 the longitudinal section of the appendix shows a sudden cessation of the normal coats at a point about 2 cm. from the tip, where for a distance of about 1 cm. the walls consist of connective tissue continuous with the fibrous stroma of the omentum. At these points it is impossible to separate the omentum without tearing the tissue, while in other parts the appendix may, as usual, be peeled quite easily out of its bed of omentum. In specimens removed during an acute attack, the omentum is found to be exceedingly hyperæmic, and there is usually more or less extravasation of blood into



FIG. 72.—ACUTELY INFLAMED APPENDIX WITH THE OMENTUM ADHERENT TO A POINT OF THREATENED PERFORATION. (SPECIMEN FROM T. S. CULLEN.)

the tissue. Purulent foci may be found here and there, and in the vicinity of the most densely adherent areas, considerable necrosis may be present. Under the microscope a general oedematous and leucocytic infiltration is found.

In the peritoneal reaction which is excited by a mild irritant, an increased transudation of serous fluid accompanies the fibrinous exudate,



FIG. 73.—APPENDIX ROLLED UP IN OMENTUM.

The proximal portion has been stripped out between the submucous and internal muscular layers. In the sectioned specimen a defect in the appendical wall has been replaced by granulation tissue. (Surg. No., 13141.)

and may even be the only evidence of the peritoneal reaction. This appears chiefly as an excess of fluid collected in the dependent portions of the fossæ of the ileocæcal region and in the pelvis. At other times the fibrinous exudate is permeated with serous fluid and appears as a thick, watery, translucent membrane, which is exceedingly soft and friable. Sometimes the serum is pocketed in the midst of the fibrinous exudate, and as the adhesions become organized the surface of the appendix and



FIG. 74.—ENCYSTED PERITONITIS SURROUNDING THE TIP OF THE APPENDIX.

the surrounding peritoneum may be studded with minute, clear, transparent blebs, varying in size from a pin-head to a split pea, while now and then cysts of considerable size are formed, in some instances inclosing a part of or even the whole appendix. Fig. 74 shows an appendix with a peritoneal cyst attached to its tip, observed at autopsy in a woman dead of an intercurrent disease. The appendix extended directly toward the vertebral column, and was adherent in its distal portion. Attached to the tip was a transparent cyst the size of an apricot, containing perfectly clear, yellow fluid. The tip of the appendix was thickened, fibrous, and obliterated, and projected a little way into the cyst.

HISTOLOGICAL EXAMINATION.—Histological examination of the peritoneum at the outset shows dilatation of the blood-vessels and oedema of the subserosa, with proliferation of the endothelium, swelling of the connective-tissue cells, and more or less leucocytic infiltration. On the surface there is a slight fibrinous exudate mingled with occasional leucocytes. As the infection continues there is more or less destruction of endothelium, and on the roughened, denuded surface an abundant deposit of fibrin and leucocytes occurs. Extravasations of blood both into the subserous tissue and upon the surface are common and may be extensive. In the slightly turbid exudate a few polymorphonuclear and small round cells are found, also large phagocytic cells derived from the endothelium. Very soon the endothelium, as well as the connective tissue, presents evidence of rapid proliferation, newly formed blood capillaries extend into the fibrinous deposit, and the cellular infiltration, which at first consisted of polymorphonuclear leucocytes, contains an increasing proportion of small round, and plasma cells. Organization and cicatrization then proceed more or less rapidly. As organization becomes complete, portions of the serous surface may be enclosed by the adhesions. The endothelial lining of the enclosed area then gradually extends around the adjacent surface of the adhesions, forming an endothelial-lined sac which finally becomes distended with serous fluid and forms transparent peritoneal cysts.

PERI-APPENDICAL ABSCESS.—The most frequent and most important complication of appendicitis is the occurrence of circumscribed purulent peritonitis and suppuration in the contiguous retroperitoneal tissue. This accident may happen in the presence or absence of perforation, but is most frequently associated with perforation or with gangrene. The migration of bacteria from the lumen of the appendix, either by penetration of the appendix walls or by means of a perforation, is essential to the production of a suppurative peri-appendicitis. The chief factors concerned in encapsulating the purulent exudate and preventing its general distribution are the presence of old adhesions, or the occurrence of a plastic exudate, which precedes the suppurative process and serves to glue together the neighboring intestinal coils, thus forming a more or less perfect barrier to the further extension of the infection. The slight inflammatory reaction which produces the viscid fibrinous exudate has already been noted as

occurring in the early stage of acute appendicitis, and, excepting in some cases of very early perforation or rapid gangrene, usually precedes the penetration of micro-organisms through the walls. The pre-perforative stage of deep-seated ulcers also is marked by a local peritoneal reaction which may cause protective adhesions to form before the floor of the ulcer gives way. In some cases the dangerous area may in this manner be effectually sealed over, but when this barrier is slight it is gradually penetrated by micro-organisms and a purulent process is set up. Fortunately, as the suppurative process advances, the reaction on the part of the tissue tends to form a limiting wall. At the outset this consists of a plastic fibrinous substance of variable thickness. If the infective material is of high grade of virulence, or if a large amount of it is poured out, this barrier often gives way, but in the majority of cases it resists the first onset, increases in thickness, and undergoes speedy organization, so that in a short time there is a firm dense protective wall of organizing tissue. In favorable cases, while the activity of the pyogenic organisms causes degeneration and liquefaction of the inner coats, in the peripheral layers there is an active, productive, inflammatory process which out-balances and finally limits the degenerative process in the interior.

The position of a circumscribed appendical abscess depends chiefly upon the position of the cæcum, the direction and length of the appendix, and the location of a perforation, but it is influenced by gravity and by the resistance of the surrounding structures. The wide range of the location of the abscess is graphically represented in Chap. XVIII. Naturally, the commonest site is in the right iliac region, and next in order of frequency is the pelvis. The occurrence of pelvic suppuration in cases in which the appendix does not descend in this direction and has no apparent connection with the abscess is frequently observed. The right iliac abscess is usually below and exterior to the cæcum, but may be medianward, anterior or posterior. It is generally at some point in direct relation with the abdominal wall and is immovable. In one group of cases, however, the abscess may be more or less movable within the abdominal cavity. These develop in the midst of intestinal loops or between the two layers of the mesentery, or between the intestine and the omentum (an excellent example is shown by SONNENBURG, see "Perityphlitis," Plate III), or, again, a small focus of suppuration may be embedded within the omentum, which is wrapped around the appendix. The most favorable locations as regards the general condition of the patient, and from the therapeutic stand-point, are the pelvis and flanks. In these regions there is less danger of septic absorption, owing to the small number of peritoneal stomata and the relatively poor lymphatic circulation. A large abscess in the flank, however, which extends upward, may involve the subphrenic region, where the possibility of absorption is very great. A suppurative process localized amidst coils of intestine is especially dangerous, because of the ready absorption of septic material through the abundant lymphatic supply of this region and on account of the extensive involvement of the intestinal

coils, with the added danger of toxæmia from absorption of intestinal bacteria or of their products.

Surgical intervention shows the most satisfactory results when undertaken at the stage where the suppurative process is definitely localized by a firm wall of organizing tissue, and on this account many surgeons advocate delay until this "walling off" process is well established. Unfortunately, there are several factors to be reckoned with, which materially diminish the benefits to be gained from this expectant method of treatment.

1. The abscess wall may be imperfect at one or more points and gradually give way, forming secondary abscesses which may be definitely circumscribed, or may in turn proceed to form other purulent foci, the progressive fibrinopurulent peritonitis of Mikulicz.

2. Bacteria may slowly penetrate the apparently intact wall of the abscess, and cause secondary abscesses to form, which, however, do not communicate with the original abscess focus. These cases are particularly important from the therapeutic stand-point, as the operator, finding a circumscribed abscess with intact walls, may not recognize the presence of the secondary pockets and so fail to evacuate and drain them.

3. The heightened virulence and rapid accumulation of fluid may cause necrosis and rupture of the abscess into the general peritoneal cavity, with an ensuing generalized peritonitis; or, without rupture of the abscess, virulent micro-organisms may penetrate its walls and induce spreading or generalized peritonitis.

4. The abscess may rupture in other unfavorable directions, as into the pleural cavity or the lungs, into the gall-bladder, into some portion of the urinary tract, or it may perforate the fascia transversalis and produce a wide-spread phlegmon of the abdominal walls. It may erode the large blood-vessels, or cause septic lymphangitis or phlebitis.

5. Profound septicæmia may develop.

RETROPERITONEAL ABSCESS.—When the appendix is situated behind the cæcum and is extraperitoneal, an abscess may develop entirely without the general peritoneal cavity. Usually in such cases the posterior aspect of the cæcum is devoid of a peritoneal covering and forms part of the abscess wall. In some instances, however, the cæcum may be wholly intraperitoneal, while the appendix lies behind the peritoneal lining of the posterior abdominal wall, in which case the cæcum may not be involved in the suppurative process. More rarely the appendix is covered by the peritoneum of the posterior surface of the cæcum, and an abscess may develop in the posterior cæcal wall, from there extending upward into the abdominal wall. In exceptional instances extraperitoneal abscesses form, when the appendix is in the subcæcal position and is provided with the usual peritoneal investment. This may occur in different ways. The infection may extend by way of the mesappendix, either by direct propagation from a purulent focus in the mesentery, with or without perforation of the appendix; or by means of the lymphatics. In other instances the appendix has been connected by adhesions to the abdominal parietes, in

which case the double peritoneal layer, united by granulation or scar tissue, is penetrated by the pyogenic bacteria, and the suppurative process then continues extraperitoneally. Finally an intraperitoneal abscess may penetrate the abdominal fascia and become extraperitoneal.

Abscesses developing behind the peritoneum may infiltrate the surrounding abdominal wall, or may burrow between the peritoneum and subjacent musculature in various directions. The muscles of the lumbar region are frequently involved and a huge abscess may form, pointing in the lumbosacral region or extending along the iliopsoas muscle to the thigh or inguinal region. G. W. CRILE, of Cleveland, has had a case in which the abscess extended from the right iliac fossa down the inner aspect of the thigh to the popliteal space, where there was a large collection of pus. In some cases the iliopsoas muscle becomes completely gangrenous, and the purulent process may even involve the periosteum of the lumbar vertebræ or of the iliac bones.

A glance at the anatomical relations of this part shows with what facility the infection may extend upward into the lax perirenal tissue or, advancing still further, how easily a subphrenic abscess may develop extraperitoneally. As has been noted previously, a circumscribed periappendical abscess of intraperitoneal origin may also extend to the subphrenic region. A subphrenic inflammation is not such an uncommon complication of appendicitis as one would suppose. In 86 personal cases no less than 7 showed some periphrenic inflammation, although several of them could not strictly be classified as abscesses. In such case perforation of the diaphragm may result in a pyothorax, or, owing to the rich anastomoses between the lymphatics of the abdominal and pleural surfaces of the diaphragm, a septic pleuritis may develop in the absence of perforation. In 4 out of our 7 cases of subphrenic abscess observed at autopsy, the process had extended to the pleural cavity, but in none was there a perforation of the diaphragm. The purulent process may extend along the course of the large vessels beneath Poupart's ligament, and into the groin. An apparently rare condition is found in cases of retroperitoneal pelvic abscess (see Chap. XVIII). In a case described by LENZMANN, the purulent process extended behind the peritoneum to the splenic region.

The contents of the abscess vary in amount from a few cubic centimetres to a litre or more. In a case cited by FITZ more than a gallon of pus, liquid feces, and scybala were removed. An apparently large abscess may consist of a thick mass of oedematous, infiltrated tissue, containing only a few cubic centimetres of pus. In other instances, the abscess walls are thin and there is relatively a large amount of fluid.

The contents are usually a creamy or yellowish purulent fluid of rather thin consistency, and having the characteristic odor of colon bacillus putrefaction. In rare instances the pus has a blue color due to the presence of bacillus pyocyaneus. Occasionally the fluid has an ichorous character. It is often distinctly feculent and of a brownish

color. Particles of fecal matter are sometimes found when the area of perforation in the appendix is large. When the abscess cavity communicates with some portion of the intestinal canal, a large portion of the intestinal contents may pass directly into it. An inspissated fecal mass or a concretion is found in the abscess in a considerable number of cases and it is not uncommon to find the necrotic appendix lying free in the cavity. Quite frequently there is evidence of slight hemorrhage into the cavity. EHRICH records two cases in which there were large quantities of fluid blood and clots, evidently due to erosion of a large vessel, although the exact source of the hemorrhage was not ascertained. Upon opening the abscess it is not uncommon to find bubbles of gas escaping with the fluid contents. In some cases this is due to the admixture of air from the intestinal canal, and it is especially frequent when the appendix abscess is associated with perforation of the cæcum. In other instances this phenomenon is due to the presence of one or more of the intestinal gas-producing micro-organisms in the abscess cavity, and may exist in the absence of perforation. The *bacillus aërogenes capsulatus* has been found in rare cases.

RESULTS OF CIRCUMSCRIBED PERI-APPENDICAL ABSCESS.—The disastrous consequences which may follow abscess formation have been enumerated above. The attack, however, may terminate in a spontaneous recovery, leaving in some instances an obliterated appendix and immunity from further attacks; in other cases, a deformed appendix, which is one of the most important factors in causing future attacks; and in other cases still, adhesions remain which are often the cause of chronic digestive disturbances and are a source of danger, in that they form constricting bands, beneath which a loop of intestine may become incarcerated.

Resolution may be brought about in two ways: namely, by rupture of the abscess in a direction which insures favorable drainage, or by gradual absorption of the inflammatory products. SAHLI believes that drainage is a much more important factor than absorption in promoting resolution. In either case, as in non-suppurative forms of peritonitis, the subsidence of the inflammation is followed by the disappearance or shrinkage of the mass.

Resolution following rupture of an abscess.—As the abscess progressively enlarges, the increasing pressure impedes the productive inflammatory process in the periphery, and also tends to produce tissue necrosis, until finally the abscess wall gives way at the point of least resistance. This end is further hastened by the increased activity of the bacteria at the point of lessened resistance. The abscess may rupture in such a direction that more or less perfect drainage is established and a spontaneous cure may result.

Rupture through the abdominal wall, or into the intestinal canal.—The general tendency is for rupture to occur through the abdominal wall, or into some portion of the intestinal canal. The relative frequency with which the abscess opens through the

abdominal wall, or into one of the body cavities, is indicated by the following statistics collected by SONNENBURG ("Perityphlitis," 1887, combined by A. O. J. KELLY):

Through the abdominal wall.....	46
Into the cæcum.....	40
Other portions of intestinal canal.....	11
Peritoneal cavity.....	8
Pleural cavity.....	6
Urinary bladder.....	3
Uterus.....	1

MÜHSAM's statistics also show that rupture occurs oftenest through the abdominal wall, and next in frequency into the intestinal canal, but give the rectum as the part of the intestine most commonly involved. The third direction in order of frequency, according to MÜHSAM's statistics, is through the vagina. Other writers do not regard spontaneous rupture through the vagina as a frequent occurrence.

Rupture through the abdominal wall usually occurs in the right flank, but is sometimes found in the back, and is not infrequent at the umbilicus. In the latter case an inflamed ductus omphalomesentericus is often suspected, the differential diagnosis before operation being sometimes impossible. Rupture through the abdominal wall or into the intestinal canal is most favorable for a spontaneous cure. If thorough drainage is established, the cavity is rapidly obliterated by granulation, and the opening soon closes. In a considerable proportion of cases, however, a fistula forms which may close spontaneously in a few weeks, or may persist indefinitely. In some instances an apparent cure is followed by re-opening of the sinus and increased discharge, which may again disappear, only to recur. A fistula following spontaneous rupture of a peri-appendical abscess may be simple, in which case the discharge is merely purulent; or the fistula may be fecal. The fistula may also be single or multiple. In one of Sonnenburg's cases there were several sieve-like perforations of the integument. The persistence of a simple fistula is usually due to the presence of some focus of infection, often an enterolith or foreign body, and after this comes away in the discharge, or is removed, a spontaneous cure soon follows. In some instances the failure to close spontaneously seems to depend upon the rigidity of the inflammatory walls of the sinus, which prevents approximation of its sides and delays the absorption of the pyogenic lining. A thorough curetting of the sinus in such a case usually results in speedy cure. Very often, after the spontaneous or operative opening of the abscess, a fecal fistula forms, usually communicating with the cæcum either at a point corresponding to the base of the appendix, or at some other point where partial necrosis has occurred prior to the evacuation of the abscess. There is usually a single opening into the bowel, but sometimes there are several. Fecal fistulas commonly close spontaneously. The failure to do so, as in simple fistulas, may generally be attributed to the presence of an infective focus in the fistulous tract where drainage is

defective. The eversion of the mucosa into the channel probably delays the approximation of the margins of the intestinal defect, but rarely extends far enough to prevent the final obliteration of the sinus.

The evacuation of the abscess cavity into the intestinal canal may also result in complete disappearance of the perityphlitic mass. Such cases are too common to require enumeration. There is generally the history of the presence of a large tumor associated with the usual clinical signs of intra-abdominal suppuration, then the sudden disappearance or diminution of the mass accompanied by the passage of pus *per rectum*. Fecal concretions may be discharged with the fluid portions of the abscess contents and even a part or the whole of the appendix, which has sloughed off from its attachment, may also be discharged. POHLMAN describes a case observed at autopsy in which the appendix formed a canal connecting the duodenum with the cæcum. In some cases there are coincident openings into the bowel and the bladder, and in a case described by SEDILLOT, vesical, intestinal, and abdominal fistulas had formed.

In some cases the evacuation of the abscess contents is only partial, and fecal concretions, foreign bodies, or collections of infective material may remain; and, again, a wide defect in the intestinal wall may form, through which the contents of the bowel pass into the abscess cavity. Not uncommonly an enterolith or foreign body which has remained in the cavity finally becomes encapsulated in a dense bed of adhesions. In one case recently observed, a concretion was found embedded in the muscular coat of the transverse colon a short distance from the tip of the retrocæcal appendix. It is probable that in this case the abscess had discharged its contents through a small opening in the intestinal wall and that the concretion had been unable to pass through.

The pouring out of feculent material from the intestinal canal into the abscess cavity is always attended with unpleasant and often disastrous consequences. The conditions present are most favorable for heightening the virulence of the contained micro-organisms and septic absorption progresses rapidly. CHRISTOFFERS reported a case in which a perityphlitic abscess ruptured into the rectum. The temporary improvement following this event was succeeded by a rapid return of the unfavorable symptoms. Autopsy showed a large cloaca containing fecal material in Douglas's *cul-de-sac*, which communicated with the rectum through two ragged openings. GRAWITZ has described a similar case of stercoral abscess. SONNENBURG could find no reference in the literature to perforation of a peri-appendical abscess into the gall-bladder, but describes a case which came under his own observation. The patient had had several perityphlitic abscesses evacuated, and then a new collection of pus, which was connected with the original cavity by a narrow channel, pushed in between the mesentery and the under surface of the liver and opened into the gall-bladder. The abscess contained dark, bile-stained pus. BREWER has reported a case in which an empyema of the gall-bladder occurred, but he does not describe a close connection between the two cavities.

Rupture into the Bladder.—There are numerous observations relating to infections of the bladder accompanying appendicitis and a few instances of involvement of the ureter and of the pelvis of the kidney. The toxic and infective lesions of the kidney, consisting usually of an acute parenchymatous nephritis, are common to all acute infections, and present nothing peculiar in their association with disease of the appendix. A purulent cystitis, or a ureteritis with ascending pyelonephritis, may be produced by the direct penetration of the bladder or ureteral walls by infective micro-organisms from a surrounding inflammatory mass. In other cases the bladder wall is perforated, and the appendix or a peri-appendical abscess drains directly into the bladder. A true vesico-appendical fistula is comparatively rare, but the rupture of a pelvic abscess of appendical origin into the bladder is not uncommon. KEEN, describing an instance of the former condition in 1898, could not find a similar case in the literature, but commented upon the well-known occurrence of the latter. Out of 25 cases of perforation of the bladder collected by APPUN, in 4 cases only was there a direct communication established between the appendix and the bladder. In many cases of appendical abscess, the suppurative process is localized well back in Douglas's *cul-de-sac* and the bladder is not affected. In other cases, however, the lateral fornices and the space of Retzius are involved, the bladder then forming part of the abscess wall. As the pressure within the abscess increases, the portion of its wall which is least resistant gradually gives way, and finally rupture occurs, sometimes into the bladder, sometimes into the rectum, or even in both directions. As a rule, an acute cystitis precedes the rupture of the bladder wall, but in a few instances the mucous membrane has remained perfectly smooth and normal, even while a large abscess has been draining into the bladder. In a case described by HALLÉ an acute vegetative cystitis, associated with severe hæmaturia and the presence of a perivesical mass, led to the diagnosis of a new growth of the bladder wall. In this case two minute perforations in the midst of polypoid outgrowths in the bladder led into a hyperplastic inflammatory mass having a cavity as large as a fist, filled with clotted blood. The appendix was partly embedded in the wall of the mass. In some instances the inflammation of the bladder wall induces the formation of phosphatic calculi, and in a few cases extravescical calculi have formed in the inflammatory tissue.

In some instances the establishment of drainage by way of the bladder has resulted in the complete disappearance of the inflammatory mass, and is soon followed by the spontaneous closure of the vesical fistula. Again, however, drainage may not be efficient, urine may pass into the abscess cavity, and the patient finally succumbs to the effect of the prolonged suppuration or to peritonitis. In some cases the lumen of the appendix or some portion of the intestinal canal may communicate with the abscess and a vesico-intestinal fistula is indirectly established.

True vesico-appendical fistulas, as already stated, are rare. The first essential factor in their development is that the appendix should become

adherent to the bladder, which presupposes an abnormally long appendix in the pelvic position, or a high position of the bladder. To the latter factor may doubtless be attributed the fact that in four out of five cases the trouble dated from early childhood. Two of the patients were four years, one seven years, and one eight years of age when the first evidence of the trouble appeared. When adhesions have formed between the organs, the further course of the process is readily understood. The usual tendency of the tip to show the most pronounced ulcerative and gangrenous lesions is doubtless increased when the appendix is fixed in this position, and the infective process readily spreads to the contiguous bladder wall. But the most important factor is unquestionably the influence of foreign bodies. With the exception of APPUHN's case this factor was present in all. In KEEN's case the patient, when seven years of age, was troubled with dysuria, and passed a pin *per urethram*, probably from the vermiform appendix. KINGDON's patient, a boy seven years old, for three years had had repeated attacks of dysuria, relieved on each occasion by the passage of a worm from the urethra; in this case also the bladder contained a calculus with a large pin embedded in its centre. There were two fistulous openings from the bladder into the appendix (see Chap. VIII). In the case described by KRACKOWITZER the patient, when eight years old, passed a living worm *per urethram*, and some years after another worm and some berry seeds. In JERVALL's case the patient, between the ages of four and ten years, had four attacks of intestinal inflammation followed by vesical symptoms, and at one time vegetable matter was demonstrated in the urine. A stercoral calculus was present in the bladder. In all of these cases the true nature of the trouble was only discovered later, at operation or autopsy. In the older literature there are many highly suggestive descriptions of cases in which intestinal worms, fecal concretions, and other foreign bodies have been passed by way of the bladder, a vesico-intestinal fistula in some instances persisting. These cases, however, lacked the control of autopsy *in vivo* or post-mortem examinations.

Cases in which the perityphlitic abscess ruptures into the thoracic cavity, involving the pleural cavity, lungs, or pericardium, are frequently observed at autopsy. The event, however, is not necessarily fatal, as there are many cases recorded in which recovery has succeeded the perforation of the diaphragm and subsequent discharge of the abscess contents through an intercostal space. H. A. MCCALLUM relates a case in which at autopsy, where the person sixteen years before had suffered from peritonitis accompanied with abscess of the lung, the appendix was found on the upper surface of the liver and showed traces of an old inflammation. There were also evidences of the discharge of pus through the eighth intercostal space and by the lung.

Resolution by Absorption.—That resolution sometimes follows the absorption of the exudate in purulent as well as non-purulent peri-appendicitis, is evident from the clinical history and operative findings in numerous cases.

It is not uncommon to find a definite, large mass gradually diminish in the absence of any evidence pointing to a rupture into the intestine, and at operation after the symptoms have subsided dense adhesions are found, embedded in which there is an enterolith or foreign body, indicating that there had been a large perforation of the appendix and a strong probability that the original mass had contained a purulent focus. In many instances resolution is only partial, a chronic inflammation or a latent focus of disease remaining indefinitely. A complete cure is effected when, all organisms being destroyed, the fluid portion of the abscess contents first becomes absorbed, then the solid constituents become disintegrated and absorbed (cytolysis) and the remaining organized portions of the abscess wall undergo cicatrization, so that, finally, the only evidence of the former mass consists in more or less numerous adhesions.

In other instances, only the fluid contents are absorbed, and the solid portions, becoming desiccated, form the centre of a dense mass of inflammatory products. Roux observed a case in which the walls of the abscess had become calcified. Micro-organisms of low virulence may also be present in a quiescent state for months or years, or, again, the contents of the abscess may be wholly absorbed, with the exception of an enterolith or foreign body, which escapes from the appendix and remains a source of irritation, to excite a chronic inflammatory reaction. This reaction sometimes appears to be greatly in excess of the amount required for a simple reparative process, the tissues being stimulated to a persistent overgrowth in some cases where the irritation was very slight. Quite often, when operating upon a patient with a history of a tumor, a dense mass of inflammatory products is found, having as a nucleus a small focus of necrotic substance or a foreign body, or there may even be an empty cavity lined with granulation tissue. There are numerous cases in which the excessive productive inflammatory process has led to the suspicion of the presence of a new growth ("*Appendicite à forme néo-plasique*," Pozzi). The essentially chronic nature of the reaction, often associated with an insidious onset, is suggestive in its clinical features of a neoplasm, and the dense solid tumor found at operation apparently confirms the diagnosis, which, however, the pathological examination and further course of the disease entirely disprove. The following cases observed in the surgical department of the Johns Hopkins Hospital are interesting examples of this condition.

(J. H. H. Surg. No. 11,812.) Male, age thirty. Complaint, tumor and persistent pain in the right iliac fossa; progressive wasting. Insidious onset three months before admission. No fever, nausea, nor vomiting. In the right iliac region there was a slightly irregular, hard mass about 5 cm. in diameter. It was apparently fixed. At operation, dense pericæcal tissue resembling carcinoma was cut through, exposing the cæcum, the whole posterior wall of which was found indurated, while the glands in the neighboring mesentery were enlarged. As the growth was deemed ineradicable, a gland was removed for diagnostic purposes and the abdomen closed. Microscopic examination showed a simple adenitis, and two years later the patient was enjoying excellent health.

(J. H. H. Surg. No. 5686.) Male, age nineteen. Admitted in the second attack of appendicitis; first attack six months before, acute, with abscess. The present illness began three weeks before with slight pain, associated with rapid failure of health. No intestinal symptoms. Temperature 100° F. The abdominal walls were œdematous and

a slightly tender mass occupied the right iliac fossa, extending beyond the median line. On rectal examination a smooth, hard, fixed mass was palpated. At operation the tumor was found to consist of whitish-red, dense tissue surrounding a mass of necrotic material. A diagnosis of sarcoma was made. The cavity was curetted and drainage inserted. After recovering from the operation the patient was sent home to die. Six years later he was perfectly well.

SONNENBURG cites a case of SCHEDE's, who, thinking that he was dealing with a carcinoma, found an old abscess with dense, thick walls, which, however, still contained fluid. In a case described by FENGER the hardness of the mass associated with dilatation of the subcutaneous veins strongly suggested a new growth. The removal of two stercoral concretions was followed by the disappearance of the mass. Similar cases have been described by RICHARD, FABRE, and others.

Spreading and Generalized Peritonitis.—By diffuse or spreading peritonitis is meant that while the entire peritoneal cavity is not involved, the inflammatory process is, nevertheless, not definitely localized, although there may be signs of an inefficient tendency to become limited, and the reaction is usually most marked in the region of the appendix. In generalized peritonitis there is no evidence of any attempt toward a localizing process, and practically the whole cavity is involved.

Diffuse peritonitis is usually regarded as one of the more remote complications of appendicitis, but, nevertheless, is apprehended with dread as an accident liable to occur without warning in any stage of the disease and in cases of apparently mild form as well as in those which present the most severe clinical symptoms.

It is difficult to estimate its relative frequency, as hospital statistics for obvious reasons probably give too high a proportion of cases. However, an approximate idea of the frequency with which it occurs may be obtained from the percentage of cases found at operation on cases of appendicitis, and from the number of cases of peritonitis in which the appendix was the source of infection, compared with the number having some other origin.

In the surgical department of the Johns Hopkins Hospital, out of 600 operations on cases of appendicitis, diffuse or generalized peritonitis was present in 61 cases, or 10 per cent. There were 104 cases of diffuse peritonitis exclusive of those following gunshot wounds of the abdomen and post-operative infections. In these cases the chief sources of the infection were,—

Appendicitis.....	61
Typhoid perforation.....	15
Intestinal neoplasms.....	4
Amœbic dysentery.....	2

Other causes were acute intestinal obstruction, hernia, volvulus, gangrene following thrombosis of mesenteric vessels, acute cholecystitis, etc.

Diffuse or generalized peritonitis in connection with appendicitis may occur in the following ways:

1. As a result of perforation or gangrene of the appendix.
2. Through rupture of a circumscribed peri-appendical abscess.
3. By means of infection by continuity from the inflamed but not perforated appendix, or from a circumscribed intra- or extraperitoneal abscess without rupture. In infection by continuity, the pathogenic organisms penetrate the diseased but intact wall of the appendix, or the limiting membrane of the abscess.

The frequency with which generalized peritonitis follows a primarily localized peri-appendical suppuration is seen in autopsy findings. H. C. CHRISTIAN (quoted in "The Vermiform Appendix and its Diseases") found in 29 out of 54 cases of general peritonitis evidence that there had been at first a localizing process which had resulted in a more or less completely walled-off abscess, and that subsequently leakage had taken place from this with a resulting generalized peritonitis. The remaining 25 cases revealed no sign of any attempt to limit the process.

Perforative appendicitis may be the means of precipitating into the abdominal cavity bacteria so virulent and in such a quantity that death occurs within a few hours, but at the autopsy examination almost no perceptible reaction on the part of the peritoneum is found. In these cases the rapidly fatal issue is due to acute sepsis, which may be the result of toxæmia alone or of bacteriæmia. These rapidly fatal infections most often follow the bursting of an acute peri-appendical abscess, or of an appendix distended with pus, the conditions in the pent-up exudate being most favorable to bacterial activities. This highly septic material is soon distributed over a large portion of the peritoneal surface and is immediately absorbed. MURPHY mentions a case in which an abscess of considerable size ruptured into the peritoneal cavity. In two hours there were symptoms of extreme shock and in twelve hours the patient was dead. In these cases the peritoneum has not had time to react before the whole organism is overwhelmed by a general toxæmia. Fortunately, such cases are not common, and as a rule in fatal cases the patient lives from thirty-six hours to three or four days. There is then a well-marked peritoneal reaction.

The most fatal variety of peritonitis is characterized by a very small amount of exudate,—dry peritonitis or peritonitis septica. There may be only a drachm or two of bloody serum and a few scattered flakes of lymph, but the serosa, wherever it has come in contact with the septic material, is an intense red and has the appearance of abrasion due to destruction of endothelium. These cases, according to MURPHY (*Med. News*, 1895, vol. 66, p. 1), always die, whether operated on or not.

In most instances of spreading or generalized peritonitis, resulting from either a perforative or a non-perforative appendicitis, there is an abundant fibrinopurulent exudate, the fibrinous element in some cases being greatly in excess, while at other times there is a large amount of purulent fluid and a very slight fibrinous deposit; and, again, the solid and fluid exudate may be in more or less equal proportions. A copious serous or purulent exudate has been shown to be of great value in diluting

and thus delaying the absorption of the septic material, while on account of its powerful bactericidal properties it diminishes or entirely destroys the infective agent. It has frequently been noticed that pus, containing organisms of low virulence, may exist for some time in the peritoneal cavity without materially injuring the normal gloss of the serosa. MURPHY has pointed out that in cases of generalized purulent peritonitis resulting from appendicitis, in which the normal glistening appearance of the peritoneum was present at the time of operation, the patients recovered. He contrasts these cases with the invariably fatal ones of dry peritonitis in which a large portion of the peritoneum is denuded of its endothelial surface. The majority of all cases of diffuse peritonitis originating in the



FIG. 75.—CHRONIC APPENDICITIS.

The appendix twisted one-half around its axis and held in this position by adhesions extending from the meso-appendix to the cæcum.

appendix may be regarded as belonging between these two extremes. In most instances the septic material is poured into the peritoneal cavity in relatively small quantities, and the tissues are able to offer more or less efficient resistance to its deleterious action. The exudate, at first serofibrinous, soon becomes purulent and an increasing amount of fibrin is present; the serous surfaces become injected and lose something of their normal lustre. The intestinal loops may be partly glued together by filmy, fibrinous adhesions, or may be almost wholly covered with large plaques of fibrin. Sometimes the entire serosa is covered with a continuous coat of fibrin. Degeneration and exfoliation of the endothelium is gradually produced by the action of the septic material. The continued action of septic material of relatively low or moderate virulence

may ultimately produce degeneration and inflammatory reaction in the external layers of the intestinal walls, the injury to the muscle and nerve elements resulting in partial or complete intestinal paralysis and in consequence a stasis of its contents. This is soon followed by intestinal fer-



FIG. 70.—POCKETED APPENDIX RESULTING FROM OLD LOCALIZED PERITONITIS.

mentation and an increase in the virulence of the contained micro-organism. As LENNANDER (*Deutsche Ztsch. f. Chir.*, vol. 63, p. 1) points out, there is then a twofold danger added to the primary infection: first, in the abdominal distention pressing the diaphragm upward and impeding both the

respiration and the circulation; second, and more to be dreaded, in the rapidly increasing toxicity of the intestinal bacteria and the altered condition of the walls which permits the penetration of micro-organisms. As a result of an intestinal paralysis there is therefore increased general intoxication through absorption of toxic intestinal contents and increased general infection through the passage of the intestinal bacteria into the lymphatic circulation and blood-vessels.

In diffuse infections, when the reactive energy of the peritoneum is preserved, a severe infection usually induces a fibrinopurulent exudate. The following case, in which a fatal *streptococcus* infection was marked by an abundant serofibrinous exudate, is quite unusual.

(J. H. H. Surg. No. 14,473.) H. B., age twelve years. Admitted with a history of four days' illness, beginning with pain in the right iliac fossa and vomiting. Bowels did not move for two days. The pain continued for three days, then became less intense. On admission the rectal temperature was 101.8° F.; leucocytes, 22,000. On abdominal examination there was almost no tenderness on the left side, but slight tenderness over the whole right side, very marked in the iliac region, where a mass could be fairly well outlined. There was no muscle spasm. Upon opening the abdominal cavity the cæcum presented, its surface covered with a thick coating of white, pearly, translucent fibrin, which could be stripped off in distinct layers. This same form of peritonitis extended over the vermiform appendix and surrounding tissues. Search for the abscess was continued down into the pelvis, and the appendix found inclining in this direction, very much thickened and covered with oedematous fibrin as above. The tip of the appendix was greenish; the lumen was not opened. The mass which had been felt on examination proved not to be an abscess, but the plastic peritonitis about the cæcal region. The appendix was removed and drainage inserted. Death occurred the next day, the whole picture being one of rapid intoxication. At autopsy, the *streptococcus* was obtained from the peritoneal and pleural cavities.

Generalized peritonitis following appendicitis is fatal in a large proportion of cases, whether the patient is subjected to operation or not. That a spontaneous recovery may occur, however, is evident from the operative and autopsy findings in a number of cases. Generalized adhesions uniting the various parts of the intestine to one another and to the abdominal wall are proof of the former existence of a peritonitis. When these adhesions are especially dense in the appendix region, and the appendix, which is embedded in adhesions, is partially or totally obliterated, or presents other evidence of an old inflammation, the origin of the peritonitis is evident.

The adhesions resulting from a localized or diffuse peritonitis may be velamentous in character, uniting the neighboring structures by delicate, transparent fibres, or they may be more dense, and by producing twists and angulations of the appendix are an important cause of subsequent acute attacks. The appendix may be completely hidden by adhesions, as in Fig. 76. Sometimes adventitious pockets may be formed in the cæcal region, in which the appendix may become incarcerated. In other instances the adhesions consist of fine thread-like strands or dense fibrous cords, which extend in various directions from the appendical region, and are a common source of intestinal obstruction.

CHAPTER VII.

PATHOLOGY (CONTINUED.)

Blood-vascular Infection.—Of the remoter complications of appendicitis, those depending upon the extension of the disease by way of and involving the blood-vessels are particularly interesting.

Acute phlebitis, pyophlebitis, or thrombosis occurs as a complication or sequel of appendicitis, and may give rise to infarction, suppuration, or gangrene of the region supplied by the affected vessel, or through the various anastomoses with the general circulation they may result in embolism or in a general pyæmic process.

HOFFMANN divides the vascular complications of appendicitis into three classes:

1. Erosion hemorrhage.
2. Thrombotic and embolic processes.
3. Gangrene.

Severe, even fatal, hemorrhage has followed the evacuation of abscesses in which large veins are involved, and probably results from the suddenly diminished pressure. This accident would probably be more frequent if it were not for the inflammatory thickening of the adventitia. Rupture of the vessels may also result from the breaking down of an infected embolus or a softened thrombus. This is the probable cause of hemorrhage into the stomach or intestinal canal in cases of appendicitis.

While slowing and other irregularities of the blood flow and alterations in the vessel walls are important accessory factors in the causation of thrombosis, the chief factor in its production is an inflammatory process due to the agency of micro-organisms. The infective agent excites an endophlebitis or endarteritis which in turn gives rise to the thrombosis. The infection of the intima may occur in one of two ways: the vessel may be involved in an inflammatory process and the organisms which are the cause of the inflammation invade the external coats, and from there, by way of the vasa vasorum or the lymphatics, gain access to the intima; or (more frequently) the bacteria enter directly from the circulating blood. WELCH believes also that a form of toxic endangitis which he describes is of importance in the causation of thrombosis complicating infective and cachectic states.

If the infective process is arrested the thrombus undergoes speedy organization, being replaced by the products of a proliferative endangitis. Often, however, especially if the larger veins be the seat of the trouble, the auto-infection goes on until the whole vein or series of veins is filled with puriform fluid; or, septic embolism may form with the production of secondary thrombi with local abscesses, or with a general pyæmia.

Thrombosis of the appendical vessels, as before explained, is not infrequent in both the arterial and venous branches traversing the walls of the appendix itself, but is less common in the main appendical vessels in the mesenteriolum. It is true that when total gangrene or spontaneous separation of the appendix from the cæcum has occurred, the chief cause of the necrosis is an obstruction to the circulation, either from external pressure or from thrombosis; but this comparatively frequent accident is seldom associated with or followed by a continued infective thrombo-anginitis. The thrombosis which serves to close the open proximal ends of the divided vessels may be merely part of the general necrotic process, or it may be simple clotting such as occurs in non-infective as well as in infective conditions, and is rapidly replaced by organized tissue. GERSTER describes three unusually instructive cases of thrombosis of the main appendical vessels, which he has personally observed. In one case total gangrene of the appendix was associated with septic thrombosis of the vessels in the mesappendix, and later gave rise to secondary purulent thrombophlebitis of the portal vein with subsequent multiple liver abscesses. Operation was performed twenty-four hours after the first onset of the illness, and twelve hours after the first rigor. The appendix was found dusky, almost slate colored, and tensely distended. It was free from adhesions. The mesenteriolum was noticed to be excessively brittle, permitting the ligature to cut through it immediately, and as blood flowed neither from vein nor artery, it was concluded that these vessels must be occluded. In the course of the next twenty-four hours there was considerable improvement in the patient's general condition, and the peritoneal symptoms vanished. This temporary improvement, however, was soon succeeded by the characteristic symptoms of septic pylephlebitis, and death ensued on the seventeenth day. Autopsy showed purulent phlebitis of the portal vein and multiple abscesses of the liver.

In the two other cases, one perforative purulent appendicitis, the other acute gangrenous appendicitis, the veins in the mesappendix and the adjoining caput coli were found to contain purulent thrombi. In each case, after removal of the appendix, the thrombosed vessels were incised and drained and the patients recovered.

Involvement of the mesenteric vessels in the thrombotic process usually results in a more or less extensive hemorrhagic infarction of the intestine; thrombosis of both artery and vein produces gangrene of the part. In some instances only a small portion, less than the area supplied by the thrombosed vessel, is infarcted; in other cases a much larger area is affected. The more acute the thrombotic process, the more liable is infarction to occur. A slowly obturating thrombus, or one secondary to portal thrombosis, in which a collateral circulation has been established, may not result in infarction; but, on the other hand, acute portal thrombosis may cause extensive intestinal infarction in the absence of any disease of the intestinal vessels. Embolism, and more rarely autochthonous thrombosis of the mesenteric arteries, is more commonly the cause of intestinal infarction

than disease of the veins. The obstruction may be situated in the superior mesenteric artery or in any of its branches. As in the case of venous thrombosis, gradual closure of the artery may not be followed by infarction. The common source of an embolus is the left heart, or the aorta, but primary thrombosis of the arteries may accompany infective diseases. As a complication or sequel of appendicitis, disease of the mesenteric veins is apparently more frequent than disease of the arteries and is often associated with portal infection. Hemorrhagic infarction of the intestines in these cases is, however, exceedingly rare. In the fairly extensive literature relating to thrombophlebitis and in the vast literature concerning appendicitis this condition is apparently not mentioned.

The following case of GIBBON'S, furnished me by LONGCOPE, is of unusual interest:

The patient, a colored man nineteen years old, died two and one-half days after operation for acute perforative appendicitis associated with purulent peritonitis. At the time of operation it was noted that the cæcum presented a gangrenous area about the size of a twenty-five-cent piece, which did not appear to be in contact with the appendix. Autopsy showed a fresh fibrinous exudate covering the congested omentum and intestinal coils, while in the region of operation the omentum and intestines were matted together with a thick whitish-yellow, soft, friable exudate. The intestines were distended, with the exception of the cæcum and the terminal portion (twelve inches) of the ileum, which were purplish in color, flaccid, and collapsed. The vessels of the mesentery leading to this portion were widely distended. The ileocolic veins contained a red and white thrombus which extended for about 5 cm. into the two branches supplying the cæcum and lower portion of the ileum. In these branches the thrombus contained purulent material. About the thrombosed vessels the mesenteric glands were enlarged and softened, one being 5 cm. in size. Cutting open the infarcted area of intestine it was found to contain a thick, soft, brick-red material. The wall of the ileum was deeply congested, the mucosa was almost black and showed small areas of superficial ulceration. The cæcum presented a similar appearance. The surface of the liver presented three or four dark red, slightly elevated, well outlined, infarcted areas, 1.5 to 4 cm. in diameter. The remaining surface was finely granular, and mottled red and yellow. The consistency of the liver was softened.

In a remarkable case of FINNEY'S a primary thrombo-angitis was believed to have been the cause of the appendical disease. At the first operation the appendix was greatly swollen, almost black in color, and it was noted that the main vessels were completely occluded. At a second operation some days later there was found an extensive thrombophlebitis involving practically all of the mesenteric vessels.

The probable explanation of the exceptional occurrence of intestinal infarction in appendicitis is that there is not usually a completely obturating thrombus, a pyophlebitis being more commonly found. But, on the other hand, this complication of appendicitis may not be so rare as it seems to be from the few cases recorded as such. The wall of the completely infarcted area of intestine is thickened, oedematous, of a dark red color from infiltration with blood, and covered with lustreless peritoneum. The margins of the infarct are often sharply marked, but may pass gradually into the normal tissue. The mucous membrane is necrotic, often defective, and may be covered with a diphtheritic exudate. A considerable area of the intestine may be gangrenous; the lumen contains black, tarry blood. There is

bloody fluid in the peritoneal cavity and usually a fibrinous or fibropurulent exudate covering the infarction; there may be general peritonitis. The mesentery is oedematous and hemorrhagic. In less complete infarction the extravasation of blood may be limited to the mucosa or submucosa (WELCH).

The most frequent complication of infective angeitis and thrombosis following appendicitis is the extension of mesenteric and portal infections to the liver, by means of a propagated thrombus, or by embolic transplantation, with consequent acute hepatitis, infarctions, or liver abscesses. H. C. CHRISTIAN (quoted in "The Vermiform Appendix and its Diseases," by Kelly and Hurdon, p. 226) found 10 cases of pyelephlebitis and liver abscess in a series of 86 cases of appendicitis observed at autopsy. In all of the cases thus affected the infection was conveyed by way of the portal vein. In 4 of them the appendix had been removed at operation, in 2 the appendix was gangrenous, and in 2 more the lesion was extremely slight. It has frequently been observed that a subacute inflammatory process is more likely to occasion portal and hepatic infections than the rapidly progressive type of appendicitis. The bacteria may be transported from the appendix to the liver and develop there without affecting the venous trunks. More frequently, however, septic thrombi form somewhere in the course of the vein and we have a pyelephlebitis. The appearance of the liver varies with the size and distribution of the abscess cavities. In nearly all cases the organ is enlarged. When the abscesses are situated in the middle of the liver, they give a mottled appearance to its surface, the suppurating foci appearing as yellowish or light greenish areas against a background of fairly normal liver tissue. If the abscess is small, the contour of the liver may be unchanged, but larger abscesses produce distinct bulging of the surface, and, if the tissue thins, they may penetrate the serosa and discharge into the peritoneal cavity. The cut surfaces of the liver also present varied appearances. The intrahepatic portal veins alone may be affected and show a dark red, firm, adherent clot, a friable reddish-gray clot, or fluid puriform material. Extension from the vein into the liver may produce abscesses varying in size from a few millimetres to many centimetres. The abscesses, as a rule, are multiple and scattered through the liver, one lobe, however, being usually more affected than the others. When the liver tissue is thus infiltrated with multiple abscesses, as is usually the case, surgical intervention is useless. There are, however, two types of cases which are amenable to operative treatment: (1) cases in which the abscess is single; and (2) cases in which a single large abscess is surrounded by groups of small ones, while the other parts of the liver are little, if at all, affected.

The microscopic picture is as varied as the macroscopic. The intra-lobular veins are filled with thrombi or with pus, with their walls practically normal, and the liver tissue unchanged; or there are groups of necrotic liver-cells (focal necrosis). The exterior of the veins may appear normal,

although there is infiltration of the walls and surrounding connective tissue. There may be an acute suppurative interstitial hepatitis without pylephlebitis. When necrosis and softening begin, there are abscesses sometimes confined to the periportal connective tissue but more often involving the liver lobules. The abscess wall is sometimes formed of liver-cells, and these may be little changed, or they may be degenerated and compressed; sometimes the wall consists of peripheral connective tissue. Reparative changes may appear in the shape of granulation tissue lining the abscess cavity, which, if death does not ensue, eventually forms adult connective tissue. Degenerative changes, remote from abscess foci, are generally prominent throughout the liver parenchyma, and liver-cells about the abscess may show proliferation. While, according to LOISON, the septic organisms may reach the liver by way of the biliary, the arterial, the lymphatic, or the peritoneal routes, the venous route is the most common channel of infection. (I have quoted freely from Dr. Christian.)

Thrombosis of the peripheral veins, and, less frequently, the arteries, may occur as a complication of an attack of appendicitis, but much more frequently develops as a post-operative sequel. All the cases observed at the Johns Hopkins Hospital belong to the latter group and will be considered in connection with other post-operative complications. The chief vessels affected are the external and internal iliac vein and artery and the circumflex iliac vessels. Thrombosis may be due to direct extension of infection from a surrounding inflammatory mass, or to infection from the circulating blood, and may develop on the left as well as on the right side, the reported cases being about equally distributed between the two sides. Sometimes both sides are involved, either simultaneously or at different times. In the majority, this complication occurred during the course of a chronic appendicitis or after the subsidence of an acute attack.

PETIT cites a case in which a mild chronic appendicitis was accompanied by thrombosis of the left femoral vein, and also reports another case in which the subsidence of an acute attack was followed by thrombosis of the right femoral vein with subsequent lung embolism. There are several cases recorded in which thrombo-angeitis, consecutive to appendicitis, resulted in the permanent closure of the affected vessel. In some instances an efficient collateral circulation was established, in others the oedema and the discomfort persisted indefinitely, and in others still, the artery being involved, there was gangrene of the part supplied by the occluded vessel. SCHEIBENZUBER has described a case of perityphlitis complicated by embolism of the left anterior tibial artery with gangrene of the leg. HOFFMANN refers to a case reported by EICHHORST and adds ten new cases.

BERARD relates a case in which, at autopsy on an individual who had died in the third week of the attack, a perforated gangrenous appendix was found associated with complete occlusion of the left crural artery. The obliteration was due to the presence of a firm clot which presented traces of beginning disorganization.

A common sequence of thrombophlebitis, and probably the frequent cause of sudden death occurring during an attack of appendicitis, as the attack is subsiding, or following operation, is the occurrence of lung embolisms. PETIT has collected three instances from the literature, and has added five unpublished cases. Of these cases, two presented the physical signs of a small area of infarction in the lungs, but recovered. In six cases sudden death occurred, and the diagnosis was confirmed at autopsy.

Lymphatic Infection.—In inflammatory diseases of the appendix the infection may spread by way of the lymphatics, and may give rise to a general septicæmia, to localized lymphadenitis, or by direct continuity, by means of adhesions, or through retroperitoneal abscess formation may produce suppuration in the hepatic or subphrenic regions.

The extension of the infective process by way of the neighboring lymphatics into the thoracic duct, and so into the general circulation, is the usual sign of a general septicæmia accompanying both suppurative and non-suppurative forms of appendicitis, and occurs either in the presence or absence of peritoneal involvement. The localized lymphatic infections have received comparatively little attention, but are of considerable importance, in that a focus of infection in the lymph glands may be the cause of a prolonged illness following the removal of the appendix. The glands may suppurate, with subsequent abscess formation in the retrocæcal or retrocolic region, and may be the source of subphrenic and hepatic infection. A mild chronic appendicitis as well as an acute suppurative affection may give rise to a severe lymphadenitis. Moreover, the lymphatic infection may remain latent for months and then develop an acute process. RICARD removed the appendix during an acute attack of inflammation, marked by an appearance of subicterus, and the patient was discharged, apparently cured. Some time afterwards he returned with the same symptoms, and, his condition becoming grave, Ricard again opened the abdomen and found a chain of infected lymph glands extending from the site of the appendix toward the liver, the first two being enlarged and suppurating. Four or five glands were extirpated, and the patient made an uninterrupted recovery.

RENDU describes a case of appendicitis of obscure development, presenting symptoms of pyæmia on the thirteenth day and resulting in death ten days later. The appendix was found lying in an abscess the size of an egg in the psoas muscle. The mesenteric glands corresponding to the ileocæcal region were enormous, some being as large as an egg. They were red, hard, and injected; two had broken down, their centres containing putrid pus. There were several abscesses in the liver. Unfortunately the mesenteric vessels were not examined; the portal vein, however, was healthy.

In a case reported by AUGUY, after two attacks of appendicitis an operation à froid was performed. The appendix was found slightly adherent in the retrocæcal position. In the vicinity of the ileocæcal angle was a group of seven or eight firm, movable, non-adherent glands. One of these,

removed for bacteriological examination, furnished a characteristic culture of *bacillus coli*. The patient made an uneventful recovery.

In several other cases described by AUGUY and FERRY, infected lymph glands were found in the mesenterium. In one case in which the appendix was only slightly enlarged and a little reddened, the mesappendix contained a suppurating gland the size of a small nut.

Slight enlargement of the glands is to be expected in all active inflammations, and on removal of the primary focus of infection will soon subside. Suppurating glands, on the other hand, will often give rise to further mischief, and in all cases they should be removed or thoroughly drained.

CHAPTER VIII.

PATHOLOGY (CONCLUDED).

SPECIFIC INFLAMMATORY DISEASES OF THE APPENDIX.

By specific inflammatory affections is understood that group of cases in which a more or less distinctive inflammatory process is produced in the tissue by the action of the specific micro-organisms of the disease. Probably in most instances there is not a pure infection with the specific organism, as sooner or later a secondary infection with the ordinary pyogenic bacteria is engrafted upon the primary disease, so that in many cases the characteristic lesions are not detected. The principal affections of the appendix belonging to this division are, tuberculosis, actinomycosis, typhoid fever, and amoebic dysentery.

✓ **Tuberculosis.**—Tuberculosis of the appendix may be primary or secondary, the latter condition being due to direct extension from the cæcum, or to transplantation of the infective agent from some distant organ, usually the lungs, in which case the tubercular lesions may be disseminated throughout the entire intestinal tract, or may be limited to the appendix. In most instances the affection of the appendix is part of an ileocæcal tubercular process, the disease, as a rule, probably originating in the cæcum, and extending by continuity of structure to the appendix. Occasionally, however, the appendix presents the more advanced lesions, and, again, it is impossible to determine which organ contains the primary focus of infection. In rare instances the tubercular process is apparently limited to the appendix. HERMANN and PETIT describe cases of tubercular glands in which it seemed possible that the appendix was the portal of entry for the bacteria but was not itself affected. The simple involvement of the peritoneal coat of the appendix in a general miliary tuberculosis need only be mentioned here, as it presents no special pathological features referable to the appendix, apart from the fact that adhesions may form which may lead to an attack of acute inflammation. There are two distinct types of tubercular disease of the appendix, when primary or when secondary to the ileocæcal affection: the usual ulcerative or caseous variety, and the less common form, which is characterized by a massive connective-tissue production, the so-called hyperplastic tuberculosis. The former is often associated with a generalized intestinal infection, whereas the latter, as a rule, is localized in the cæcal region. CORNIL and RICHELOT call attention to a third variety in which a secondary colon bacillus infection, superimposed upon the tubercular infection, results in a suppurative appendicitis, the primary tuberculosis disappearing in the midst of the purulent focus. This condition, however, although of considerable interest,

is of the nature of a mixed or terminal infection, and cannot be considered a distinct form of tuberculosis. PETIT adds the two types of the tuberculous nodule, and cystic dilatation, but these are merely slight variations from the first type, the former due to the localization of the process, the latter resulting from the accidental obstruction of the lumen.

Caseous or ulcerative tuberculosis of the appendix in many cases is not recognized upon macroscopic examination. The exterior of the appendix may present nothing to distinguish the condition from a simple chronic or subacute inflammation. The serosa is usually injected. In all the cases which have come under my observation adhesions have been present, usually very light and veil-like. In Case 2* the worm-eaten appearance of the serous surface was commented upon at the time of the operation, but the true nature of the disease was not suspected until revealed by the microscope. In SONNENBURG's case a few gray miliary tubercles were scattered over the serosa in the vicinity of the thickened proximal portion of the appendix. The appendix is usually thicker than normal. In Sonnenburg's case the proximal end with the anterior wall of the cæcum formed a dense tumor, while the distal portion, though thicker, was soft. In MOSHER's case the appendix was long and tensely distended. In Case 3 the appendix was diminished in size, resembling a withered, obliterated organ. A careful examination of the interior may be more fruitful of results. The mucous membrane is injected and shows more or less extensive ulcerations, which have the characteristic caseous appearance of tubercular disease. The individual ulcer may be round or oval, or it may encircle the lumen of the appendix. The floor of the ulcer and the surrounding mucosa may be beset with minute grayish tubercles. In some instances almost the entire mucous membrane is caseous. In Case 3 the mucosa was replaced by partly caseous, partly fibrous tubercular products which caused complete obliteration of the canal. BIGGS presented a specimen of tuberculosis of the appendix, in which about one inch of the extremity was cut off from the remainder and was filled with cheesy material. Where the intestinal tuberculosis is a late complication of lung tuberculosis, the process rapidly spreads, owing to the slight resistance of the organism, and ulcers are produced which show no tendency to heal. These ulcers are apt to be especially deep in the cæcum and appendix, and may proceed to perforation. On the other hand, when the disease is limited to the cæcum or the appendix, or is merely associated with a latent or healed focus in some other part, a reparative process may be established, with a subsequent cicatrization of the ulcerated areas, and, ultimately, the production of strictures. Annular ulcers, especially, may result in almost complete stenosis.

HISTOLOGICAL EXAMINATION.—Histologically the more or less characteristic lesions of tuberculosis are found. As a rule, the process is principally confined to the mucous and submucous layers, in some cases

* For clinical histories of these cases, see Chap. XXII.

the former, in other cases the latter, showing the most pronounced changes. Generally, a few scattered foci are found in the peritoneal layer. In Fig. 77 the maximum lesions are found in the submucosa, which is much thickened

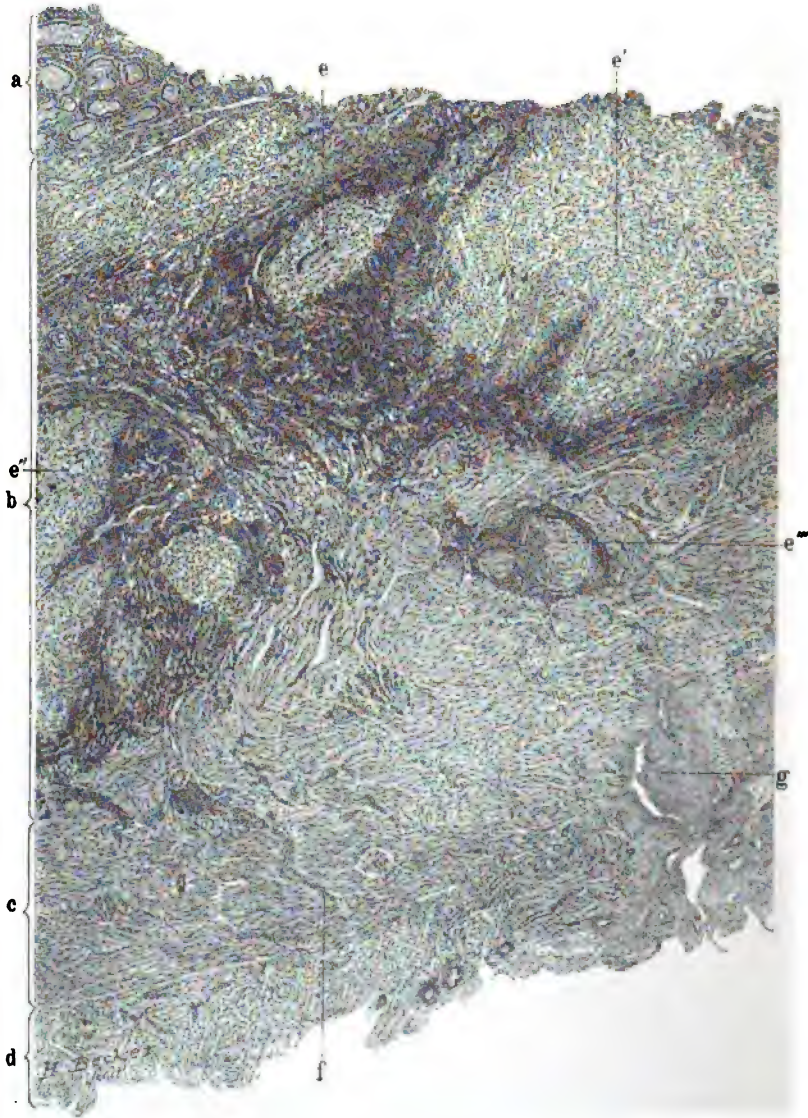


FIG. 77.—TUBERCULOSIS OF THE APPENDIX. MAGNIFIED 40 TIMES.

a indicates a remnant of the mucosa which has disappeared in other places; *b* is the submucosa; *c*, the circular and *d* the longitudinal muscular coats. Tubercles (*e*) are chiefly found in the submucosa, but also invade the musculature. At *g* a caseous area is seen. (Specimen from I. Henrotin.)

and almost wholly made up of tubercular tissue. The mucosa is almost completely destroyed. A few small tubercular foci and areas of caseation are seen in the musculature and peritoneal layers. In Case 2 the mucous membrane was but little altered, while the submucosa was studded with

miliary and conglomerate tubercles, showing extensive areas of caseation. Usually, however, there is more or less destruction of the mucosa, and, as we have seen, it may be entirely replaced by tubercular products. Typical miliary tubercles predominate in some cases, while in others the most conspicuous feature is a diffuse fibrinocaseous process. In Case 3 typical tubercles were not seen and the centre of the appendix consisted almost wholly of epithelioid cells and caseous material. Tubercle bacilli are easily demonstrated in most cases, but are rarely numerous.

At a later stage, the invasion of secondary organisms may induce a purulent process, which obscures the tubercular lesions. In other cases there is a complete fibrous transformation of the diseased areas, and it is only on the examination of numerous sections that the tubercular origin of the process is revealed. In these conditions the regional lymph glands frequently show an active tubercular process.

Hyperplastic Tuberculosis.—Since 1891, when HARTMANN and PILLIET (✓
(*Bull. de la Soc. Anat. de Paris*, 1891, p. 471) published the first detailed



FIG. 78.—HYPERPLASTIC TUBERCULOSIS OF THE APPENDIX.
In the cross-section the tubercles (a) appear as deeply stained nodules.

description of this form of intestinal tuberculosis, many cases have been reported, in the vast majority of which the cæcal region was the seat of the disease. The appendix, as a rule, was not affected, but in some instances it was involved in the cæcal tumor. PETIT has collected nine cases described as hypertrophic tuberculosis, but with the possible exception of three cases, these do not appear to conform with the distinct type which characterizes the ileocæcal affection. In a typical case the process was primary in and practically confined to the appendix. This case was described by CROWDER, to whose courtesy I am indebted for notes of the case and for the specimen pictured in Fig. 78. The appendix, which was removed at operation, together with a small portion of the adjacent cæcal wall, has been hardened in alcohol and consequently has undergone some shrinkage. It is 6 cm. long, and in diameter varies from 18 to 20 mm. in the thick median portion, and is 11 mm. near the cæcal end. It is very firm and dark, and its surface near the middle is marked by smooth

rounded elevations, consisting of infiltrated masses of subperitoneal fat. The peritoneum, with the exception of a few tags of adhesions, is smooth. The color varies from yellow to dark brown, the dark areas being due to subserous hemorrhage. Section shows greatly thickened walls and a practically obliterated lumen. The mucous membrane is 2 or 3 mm. thick and is sharply outlined from the surrounding fibrous tissue. The other coats cannot be differentiated and are represented by a dense fibrous structure of almost uniform appearance. A few yellowish foci of degeneration are seen in the subserous tissue.

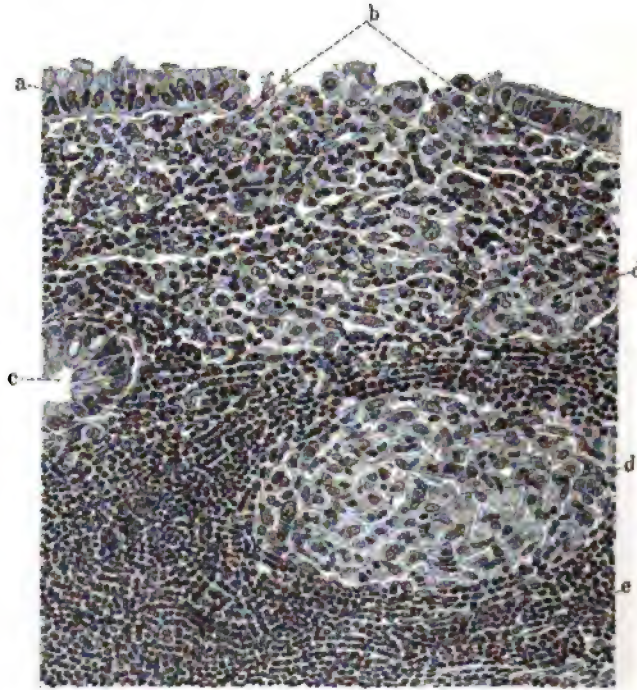


FIG. 79.—HIGHER MAGNIFICATION OF THE SUPERFICIAL TUBERCLE. MAGNIFIED 250 TIMES.

The epithelium (a) is degenerated where the tubercle reaches the surface (b). The tubercles consists of epithelioid cells (d) surrounded by a zone of dense round cell infiltration (e). The gland (c) is normal.

Microscopic Examination.—The mucous membrane as a whole is well preserved, but shows an increase of cellular elements in the membrana propria, and in places is beset with a few microscopic tubercles. It is also unusually vascular. The glandular and surface epithelium show little change, the cells staining regularly and well. At one or two points where the tubercles reach the surface the epithelial cells are irregular in form and cloudily stained; some are completely necrotic. Lymph nodes are comparatively scarce. Occasionally the centre of a follicle is occupied by a clump of epithelioid cells sometimes surrounding a central giant cell. Other nodes exhibit advanced fibrous tissue changes, probably a tubercular process. The chief alteration is found in the submucosa and circular mus-

cular coats, and here the characteristic picture of the hyperplastic tubercular process is apparent. In these layers, which are greatly thickened, the normal structure is almost wholly replaced by a cellular fibrous tissue with a more or less plentiful sprinkling of small round, and plasma cells, the latter greatly predominating. The line of demarcation between these two layers is indistinct, owing to the marked tubercular invasion of this region. In the submucosa the round cell infiltration is especially dense, and the tubercular foci are also most numerous here. These consist of aggregations of round cells, which sometimes surround a central group of epithelioid cells, containing one or more giant varieties. More often, however, epithelioid cells are lacking and the tubercles consist merely of lymphoid cells, or of a group of several giant cells surrounded by small round cells. At several points single giant cells are seen in the midst of the fibrous tissue. Many of these appear to be perfectly free from the surrounding tissue. Epithelioid cells are scarce throughout the specimen and typical caseation is entirely wanting. In the circular muscular coat the fibrous tissue proliferation is very abundant, separating the individual muscle fibres from one another. Toward the inner margin a few bundles are still preserved. Plasma cells and a few lymphoid elements are distributed generally throughout the tissue and at several points large *mastzellen* are seen. Focal tubercles are not so numerous as in the submucosa. The longitudinal muscular coat participates in the general thickening, but to a less degree than the other tissues. The subserous layer is thickened and infiltrated and contains many discrete tubercles. There are extensive areas of hemorrhage and some degeneration in this layer. Sections of the small portion of the cæcal wall removed show tubercular infiltration of the mucosa and submucosa, with a general round cell infiltration of the tissues. Many sections were examined for tubercle bacilli, but with negative results.

The most prominent feature of this form of intestinal tuberculosis is the immense hypertrophy of the bowel walls, the thickening being often increased by a fibro-adipose deposit in the subserous layer. The walls of the portion invaded vary from 0.5 to 3 cm. or more in thickness, one case described by TIEDENAT reaching 5 cm. On macroscopic examination it is often difficult to differentiate the tuberculous mass from a true neoplasm. As a rule, however, the mass in the case of a new growth is more sharply outlined than in tubercular disease. In the latter the thickening of the walls usually involves the whole circumference of the bowel, and, gradually diminishing, imperceptibly merges into the normal portion. Thus, although thickened and rigid, the normal contour of the intestinal tube is generally preserved. Sometimes, however, cicatricial contractions may produce various irregularities in the form of the mass, and in a case described by ROUTIER the growth was limited to the posterior cæcal wall. Narrowing of the lumen of the bowel or actual stenosis is commonly found, and, as a rule, is due to the gradual encroachment of the hypertrophied walls, involving the entire portion affected by the disease. Cicatrization of ulcerated areas may also produce areas of stenosis, but it is less common in this form

of tuberculosis than in the ordinary ulcerative variety. The characteristic polypoid masses found in the cæcum and in other portions of the direct intestinal canal may aid in the formation of strictures. In PETIT's case polypoid masses were found in the appendix. The cut surface of the mass presents a fairly uniform, fibrillated structure, which may bear a striking resemblance to a sarcomatous growth. Generally, however, unlike tissues invaded by a new growth, the different layers are more or less clearly defined. Yellowish foci of degeneration are occasionally seen and, as already mentioned, masses of adipose tissue are found in the outer coats. Microscopic examination reveals a picture which, though varying in many ways, is perfectly characteristic. The most conspicuous feature is the general fibrous proliferation affecting all the tissues, but most pronounced in the submucosa. There is an abundant formation of oval and spindle-shaped connective-tissue cells, also much fibrillated and homogeneous intercellular substance. Distributed throughout the tissue generally, but in varying numbers and often in clumps, are numerous lymphoid and plasma cells. In the specimen examined by myself, plasma cells were greatly in excess in the diffuse infiltration, while lymphoid cells predominated in the focal tubercles. The plasma cells were mostly of the small variety, but large forms also were present. Many showed active mitosis, or contained double nuclei. The transformation of these cells into connective-tissue cells could not be definitely determined. A few *mastzellen* and occasional eosinophiles were present in the submucous and circular muscular coats.

Microscopic tubercles are usually found in some places, particularly in the mucosa and submucosa, but are not numerous. They may have the typical structure, consisting of a central giant cell surrounded by epithelioid cells and an outer zone of small round cells, but more often there is merely an aggregation of lymphoid cells, or giant cells and lymphoid cells. Epithelioid cells and caseation may be entirely lacking. In some instances typical tubercles are absent, as in LARTIGAU's and PILLIET's cases. In Pilliet's case there was a general massive infiltration of embryonal cells, which at first sight was suggestive of a sarcomatous growth. While the lesions are most marked in the mucous and submucous layers, the muscular coats participate to a variable extent and the peritoneal coat frequently shows extensive lesions. The nature of the lesions is essentially that of a chronic productive inflammation associated with a tubercular process. By some writers, notably HARTMANN, PILLIET, and BENOIT, it is believed that secondary infections play an important rôle in the production of the special lesions found in this class of tubercular affections, while ITIÉ inclines to the belief that the tubercular infection is engrafted upon an antecedent inflammatory process. The chronicity of the process and its productive nature are most plausibly explained by the theory of an infection with attenuated bacteria. The paucity in number of the organisms usually present may have some influence upon the nature of the process, but is not in itself a sufficient explanation, for in the cases described by LARTIGAU, and by CAUSSADE and CHARRIER, tubercle bacilli were very numerous.

How the attenuation is brought about is not clearly understood. HARTMANN and PILLIET consider the action of other organisms an important factor, but, on the other hand, RAMOND and RAVAUT (*Arch. de méd. experim. et d'anat. path.* 1899, vol. I, p. 494) have demonstrated that, while in culture tubes the growth of tubercle bacilli is arrested when associated with other microbes, in the living organism, when other bacteria are present, tuberculosis develops much more rapidly. This result they believe to be due to the impairment of the resistance of the tissues and not to the direct action of the other bacteria. CROWDER (*Amer. Jour. Med. Sci.*, 1892) advances the reasonable view that individual resistance is probably an important factor in limiting the action and causing the attenuation of the bacillus: "The toxins of a given tubercle bacillus might be able to produce only slight irritation when growing in the tissues of one appendix, thus determining a conservative process of hyperplasia, while in another they might produce rapid necrosis." In support of this view he directs attention to the fact that in cases of hyperplastic tuberculosis of the cæcum it is unusual to find any rapidly progressive or destructive lesion in other parts of the body, whereas an old healed or latent tuberculosis of the lung often exists.

Actinomycosis.—Actinomycosis, like intestinal tuberculosis, shows a special predilection for the cæcal region, but, unlike the tubercle bacillus, which in most instances primarily attacks the cæcum, the actinomyces more frequently enters the vermiform appendix, and from there invades the tissues. It is generally considered that the appendix is the chief portal of entry for the infective agent in abdominal actinomycosis. While in many cases the parasite cannot be demonstrated in the appendix, the relation of the organ to the actinomycotic mass and its diseased condition plainly indicate the primary location of the infection.

In the purest form of actinomycotic infection in man the reaction on the part of the tissues is merely a chronic, productive, inflammatory process, but, as in most cases the infective agent enters through a cavity which is beset with bacteria, suppuration is an almost constant accompaniment of actinomycosis. The granulation tissue is generally bathed in a scanty, thin, puriform fluid, which, owing to hemorrhages, is often of a brownish color; but, according to PARTSCH (*Samml. klin. Vorträge (Chir.)*, 1888, p. 2833), unless secondary infection with the ordinary pyogenic organisms occurs, pus is not found. ISRAEL (*Berl. klin. Wochenschr.*, 1895, p. 377), however, states that in man the actinomyces induces suppuration, a view also held by CZERNY and HEDDAEUS (*Beiträge f. klin. Chir.*, No. 21, p. 513). In an early state the products of the infection appear as a brawny, pseudo-fluctuant, tumor mass. The tendency of the tissue to undergo fatty degeneration and its disposition toward hemorrhages result in the formation of irregular spaces, which are lined with soft, yellow or reddish granulations and contain a sparse amount of thin fluid, in which the characteristic bodies float. Some writers claim that this material emits a characteristic odor, but PARTSCH and others consider that the odor is due to

the presence of other intestinal bacteria. The disease is essentially chronic, but with rare exceptions after a longer or shorter period it ceases to be localized and invades the neighboring structures, forming indurated connective-tissue masses accompanied with a diffuse oedematous infiltration of the surrounding tissues. Softer areas are found here and there, but are not numerous. This dense scar-like connective-tissue formation is characteristic of the activities of the actinomyces, and in the chronic form is never absent. It may reach such dimensions that a true tumor is simulated. The inflammatory products embed the nerves, infiltrate and separate the muscle bundles, and invade the walls of the blood-vessels. In the dense new formation, as already mentioned, there are sparsely distributed softer areas, also of variable size, varying from slight chinks to cavities as large as a fist. Microscopic examination reveals a dense fibrous tissue proliferation invading and compressing the normal tissue. Here and there aggregations of small round cells, sometimes polymorphonuclear leucocytes, are noticed. These correspond to the softened areas observed in the gross specimen and also form the chief part of the granulations lining the cavities. As noted by MARCHAND, occasional giant cells are found. According to PARTSCH, it is only in these areas of round cell infiltration that the actinomyces is found, and often it is necessary to examine several sections in order to demonstrate the cause of the disease. The demonstration of the ray fungus is, however, absolutely indispensable to a diagnosis. The intestinal mucous membrane usually presents small areas of ulceration, which are the result of the breaking down of small nodules. The crater of the ulcer consists of the denuded muscle. The mucosa generally is deeply stained with extravasted blood, especially in the vicinity of ulcers, and as these become healed a blackish pigmented cicatrix remains. As the infection soon penetrates the intestinal walls, there is a reaction on the part of the peritoneum, the intestinal coils becoming adherent to the neighboring structures and to one another. These adhesions then become infiltrated with the hyperplastic inflammatory products, the characteristic softening and cavity formation taking place later.

The disease advances in all directions, and usually penetrates the abdominal fascia, with subsequent infiltration of the parietes, which become oedematous and indurated. Finally, necrosis takes place, and extending to the skin surface produces fistulous openings, several of which usually appear almost simultaneously. Cases of perforation of the bladder and rectum have also been reported, and rupture of the diaphragm is a common event. The peculiar soft yellow or reddish granulations lining these sinuses differentiate them from simple inflammatory conditions. The infection extends mainly by direct continuity, invading all structures, but is also propagated by way of the blood-vessels and may develop at many distant points, as in other metastatic processes. Dissemination by way of the lymph circulation has never been observed. Infection of the lymph glands sometimes occurs, but is due to their direct invasion by continuity. As the morbid process advances, the older portions may become partly absorbed

and in part reduced to a few thick bands of scar-like tissue. Thus, a large mass may gradually subside while an active process is advancing in other areas. In other instances, after free incision the granulation tissue gradually undergoes complete resolution. When the actinomycotic process is associated with an infection by the ordinary pyogenic organisms, sup-

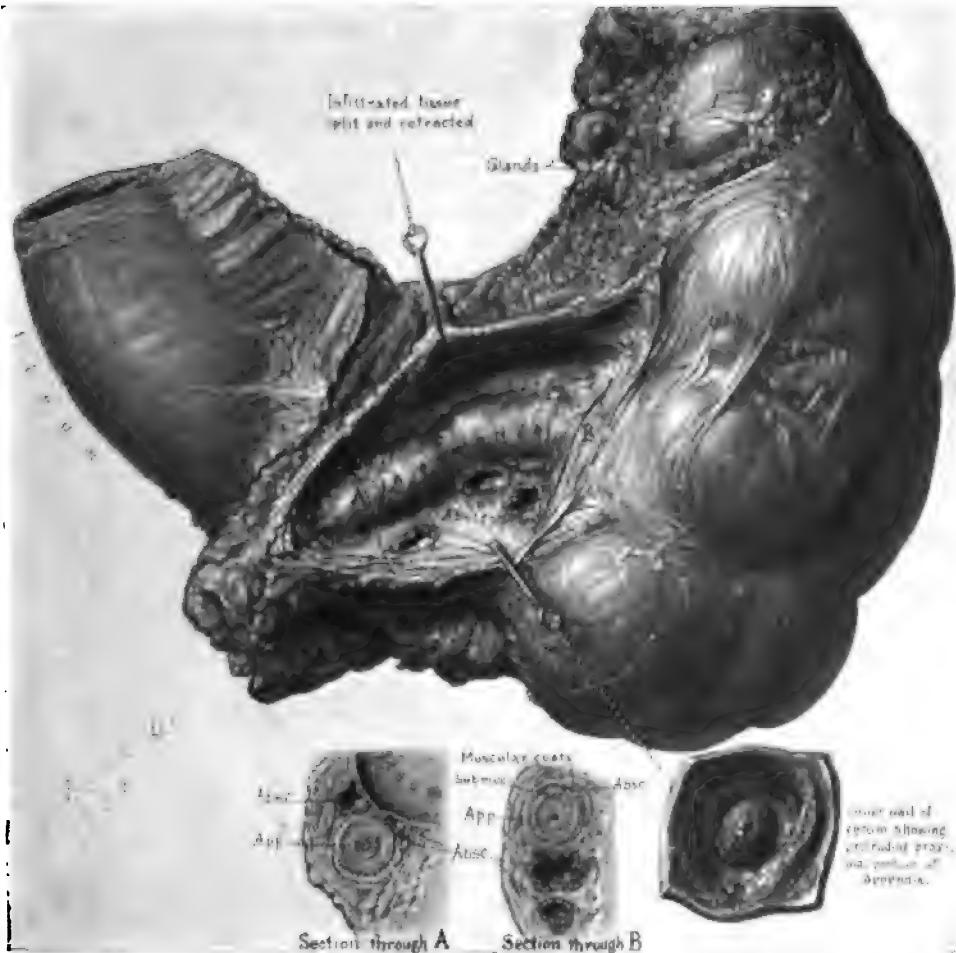


FIG. 80.—ACTINOMYCOSIS OF THE APPENDIX.

Posterior view of the ileocecal apparatus, showing the appendix enclosed in a dense mass of inflammatory tissue which is riddled with abscess foci. The appendix appears thickened and rigid and about its middle is strictured and bent at a slight angle by a band of adhesions. Sections through the distal and proximal ends show apparent obliteration of the lumen. In Section B, a minute abscess focus is visible in the external tunic of the appendix. (Autopsy, No. 2165.)

purating foci are found here and there, and true abscesses sometimes form. The patient may ultimately succumb to the secondary infection.

In the cases originating in the appendix various conditions have been found in this organ. In only a few instances, notably the cases of HELFERICH, ILLICH, and LANGHANS, and in my own, have the specific process

and parasite been observed in the appendix itself. In many cases the appendix merely shows a simple perforative inflammation. The large proportion of cases in which a fecal concretion is found suggests the possibility that the foreign body may play an important rôle in the development of the disease, either by determining a rupture, or by causing pressure necrosis, and thus facilitating the invasion of the appendical walls. In a case described by ILLICH, a husk of corn was found with the actinomyces in the appendix; and in AMMENTORP's case a barley husk was found with the actinomyces in an abscess cavity. The appendical walls are often not invaded by the parasite, which, having lodged in the canal, escapes through a perforation not due to its activities, and excites the characteristic reaction in the surrounding tissues. Again, there are cases in which the appendix has evidently been the seat of an old actinomycotic infection and partial or complete repair has supervened. Such an appendix may appear thickened and rigid, its condition resembling a chronic obliterative inflammation. The interior may show a narrowed or stenosed lumen and pigmented scars representing healed ulcerations. A case which has recently come under my personal observation is a good example of this condition. In this instance the etiological relation of the almost obliterated appendix to the actinomycotic process was not clear, and the possibility of the primarily cæcal origin of the disease was entertained. Histological examination, however, revealed very clearly the appendical origin of the trouble. For the clinical history of this case see Chap. XXIII. The chief points of interest in the autopsy protocol are as follows:

Anatomical Diagnosis.—Actinomycosis of the liver, spleen, and lungs; acute actinomycotic pleuritis with effusion; healed actinomycosis of the appendix and anterior abdominal wall; chronic peritonitis.

The omentum covers the small intestine, which is adherent to the anterior abdominal wall. Between the uterus and the sigmoid flexure there are a few adhesions to the small intestine. The liver is attached to the diaphragm by adhesions of a somewhat fibrous character. On attempting to separate the right lobe from the diaphragm an abscess cavity, 8 cm. in diameter, is broken into.

Intestines.—The serous surface is pale throughout. In the region of the appendix several coils are adherent to the abdominal walls, to the right round ligament, and, slightly, to the cæcum. The appendix can be felt as a firm cylindrical mass lying under the ileum, where it is embedded in a mass of dense connective tissue. In enucleating the appendix, a sieve-like abscess focus is found in the appendico-cæcal angle infiltrating the inflammatory mass. The appendix is 5.5 cm. long, its walls thickened, and its lumen almost obliterated. The proximal end forms a dense knob-like protuberance into the cæcum. The mucosa covering this inverted portion of the appendix and the cæcal wall are both stained a dark reddish-brown. Otherwise the intestinal mucous membrane is perfectly normal. (See Fig 80.)

Microscopical Examination.—The peri-appendical mass presents the usual hyperplastic inflammatory tissue, consisting of an abundant fibrillated or homogeneous ground substance with fairly numerous fusiform connective-tissue cells. A few lymphoid and plasma cells are distributed throughout this tissue, occasionally forming clumps, but in

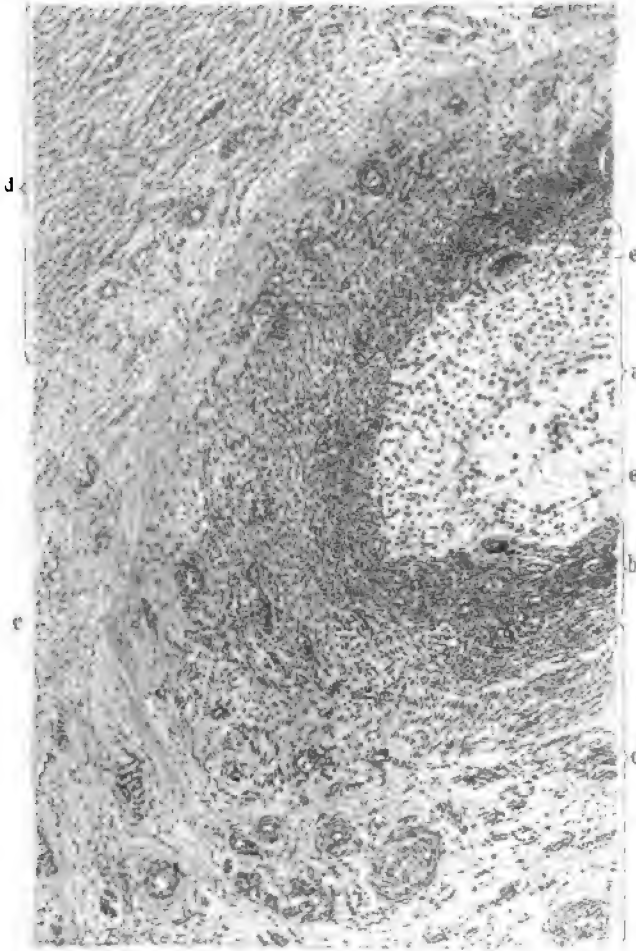


FIG. 81.—ACTINOMYCOSIS OF THE APPENDIX. MAGNIFIED 75 TIMES.

A section through the median portion of the appendix, showing a granulating cavity occupying the site of the appendical canal. The cavity *a* contains shreds of mucus, round cells, a few polymorphonuclear leucocytes, and cellular detritus. The lining of the cavity *b* is composed of typical actinomycotic granulation, the inner portion consisting almost wholly of round cells, while farther out there are abundant fusiform connective-tissue cells. Giant cells are seen at *d*. The submucosa, *c*, is thickened and fibrous, and its blood-vessels highly sclerotic. *d* indicates a segment of the circular muscular coat.

the granulation tissue lining the abscesses, polymorphonuclear leucocytes predominate and are also present wherever the parasite is found. The appendix shows the changes characteristic of chronic obliterative inflammation (see Fig. 81). Its walls, particularly the submucosa, are thickened and fibrous. The canal is reduced to a hair's breadth, and is lined with

atrophic mucous membrane, which contains a few shallow glands, but no lymph follicles. At one point, near the middle of the appendix, the mucosa has been replaced by actinomycotic granulations, consisting chiefly of round cells and containing two or three giant forms. In one place there is an area of polymorphonuclear infiltration between the subserous and internal muscular coats, and at this point the actinomyces is found (see Fig. 82). It is also present in the peri-appendical abscess. The caecal mucosa is hemorrhagic and shows slight degenerative changes. The peritoneal surface is involved in the actinomycotic mass which also surrounds the appendix.

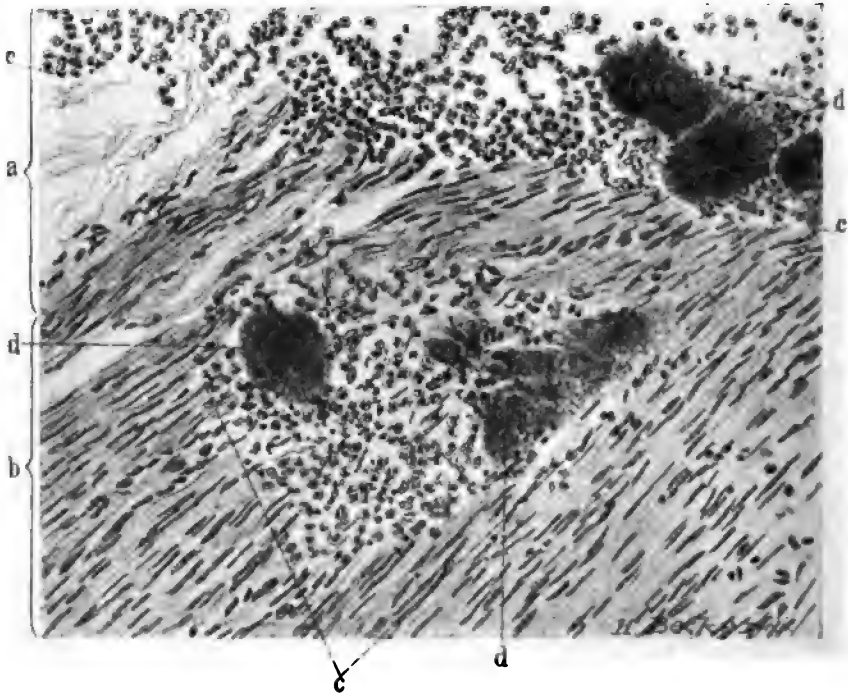


FIG. 82.—ACTINOMYCOSIS OF THE APPENDIX. ENLARGED 420 TIMES.

From a section through the wall of the appendix at the junction of the submucosa (a) and the circular muscular coat (b); d indicates parasito colonies in the midst of an abundant leucocytic infiltration (c).

Typhoid Fever.—From the stand-point of pathological anatomy the affections of the appendix arising during the course of typhoid fever may be divided into three classes of cases:

1. Those in which the appendix participates in the typhoid lesions.
2. Those in which a secondary infection with pyogenic organisms is engrafted upon the typhoid affection.
3. Those in which a simple appendicitis develops, the appendix not being involved in the typhoid infection. In these last cases, however, it is probable that the attack is often precipitated by the congestion which accompanies the typhoid infection, although there may be no specific typhoidal lesions in the appendix.

It is generally stated that the appendix is involved in about one-third of all cases of typhoid fever, and that of the perforative cases there is a perforation of the appendix in about 5 per cent. Some statistics give a higher percentage, while others again are much lower. It is not explained, however, whether these are coincident attacks of simple appendicitis or are true typhoid lesions. O. HOPFENHAUSEN (*Rev. méd. de la Suisse rom.*, 1899, vol. 19, p. 105), in a series of thirty autopsies upon typhoid subjects, found some alteration of the appendix in all, the lesions ranging from a slight hyperæmia to diffuse inflammation associated with ulceration. The ulceration was superficial.

CASES IN WHICH THE APPENDIX PARTICIPATES IN THE TYPHOID LESIONS.—These cases vary greatly in the extent and severity of the lesions. In the majority of instances there is merely a slight congestion of the blood-vessels, especially in the serous and mucous coats. In other cases the whole appendix is swollen and turgid and its lumen is practically obliterated by the swollen mucosa. The appendix shown in Fig. 4, Plate I, was removed at operation on the fifteenth day of the typhoid attack. It was greatly swollen, tense, and of uniform bright red color. On cross-section the muscular coats appeared to be distended by the greatly swollen mucous and submucous layers, which also completely filled the canal. Histological examination revealed typical typhoidal changes, without necrosis. In cases of this kind there are frequently slight extravasations of blood into the mucosa, and even into the deeper tissues. The lymph nodes may be very prominent, and they sometimes show yellow necrotic foci. In other cases, again, more or less extensive ulcerations are found, sometimes merely involving the surface of the mucosa, and sometimes extending into the submucosa and even destroying the muscular coats. The ulcers may be of pin-head size, arising from degenerated lymph nodes (as in one case of MACMONAGLE'S), or they may extend superficially over the greater part of the mucous membrane. As would be naturally supposed, the most pronounced changes are found during the acute stage of the typhoid infection. HOPFENHAUSEN found the maximum lesions during the first three weeks; and later, as in the case of the rest of the intestine, the inflammation was less evident.

The characteristic typhoidal lesions found in these cases clearly differentiate them from the cases complicated with secondary infections and from simple appendicitis. According to MALLORY, the early changes are proliferative in character and consist in hyperplasia and hypertrophy of the reticular cells of the lymph-nodes, also of the endothelial lining of the lymph spaces of all the tissues, but particularly of the membrana propria of the mucosa. The endothelium of the lymph vessels, capillaries, and veins, and to a less extent the arteries, also proliferates. These cells become epithelial in character and possess, to a marked degree, the property of phagocytosis. These large cells (macrophages of Metchnikoff), while not peculiar to typhoid fever, are characteristically abundant in that disease. Accompanying these changes

there is a proliferation of lymphoid and plasma cells while active mitosis is noticed in the glandular epithelium. In mild cases the phagocytic cells rapidly undergo fatty degeneration and disappear, the tissues soon regaining their normal condition. The degeneration of the proliferated endothelial cells lining the vessel walls frequently forms the starting-point of a thrombotic process (see Fig. 83). In severe cases tissue necrosis usually supervenes, and is explained by MALLORY as due to thrombosis of the lymph vessels and veins. In consequence of the necrosis there is inflammatory exudation which consists almost wholly of serum with very abundant fibrin. This exudation collects chiefly in the submucosa. Polymorphonuclear leucocytes are not numerous and are often absent in small

foci; in the larger foci they are usually present in considerable numbers, especially on the surface where various intestinal bacteria are invading the necrotic tissue.

A beautiful example of typhoid ulceration of the appendix has been furnished me by H. C. CHRISTIAN, of Harvard (*loc. cit.*) (Figs. 84, 85, 86). With the low magnification the entire thickness of the appendix wall is seen. The muscular and subperitoneal layers are only slightly altered, but the submucosa is immensely thickened and densely infiltrated, while the mucous membrane is completely necrotic. On the surface there is a thick layer of fibrin containing leucocytes

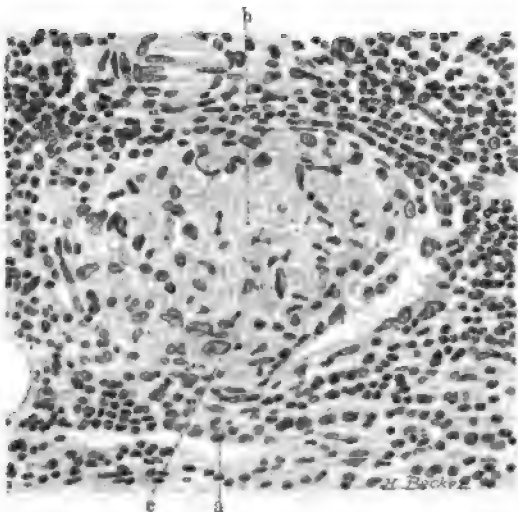


FIG. 83.—THROMBOSED VESSEL IN THE APPENDIX IN A CASE OF TYPHOID FEVER. MAGNIFIED 330 TIMES.

a. The endothelial lining of the vessel; b. the thrombus, containing large endothelioid cells (c), some of which are phagocytic. (Surg. Path., No. 3194.)

and cellular detritus, and in the underlying necrotic tissue polymorphonuclear leucocytes are plentiful. Beyond the necrosis the polymorphonuclear invasion ceases and the infiltrate is wholly made up of lymphoid and plasma cells and abundant large phagocytic cells.

Restitution may follow extensive necrosis, but, as a rule, large areas of necrosis are repaired by a connective tissue formation which is ultimately converted into scar tissue.

TYPHOID LESIONS IN THE APPENDIX COMPLICATED WITH SECONDARY INVASION OF OTHER BACTERIA.—These cases probably comprise a large proportion of those in which symptoms of an acute perforative appendicitis occur early in the course of the typhoid infection. In the gross specimen they cannot be differentiated from the simple acute appendicitides, but microscopic examination reveals the characteristic typhoid

lesions with the superimposed purulent inflammation. Two very interesting cases have been furnished by MACMONAGLE. Both appendices were removed at operation at the end of the second week of the typhoid infection, but while one shows a mixed infection, the other shows a simple

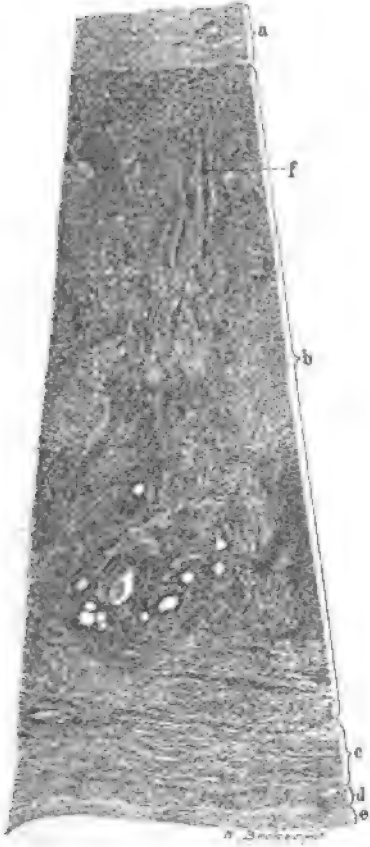


FIG. 84.—TYPHOID ULCERATION OF THE APPENDIX. MAGNIFIED 25 TIMES.

a, Fibrinous exudate; b, mucosa and submucosa, densely infiltrated and necrotic in the superficial portion; f, degenerated vessels containing leucocytes; c, circular muscular coat; d, longitudinal muscular coat; e, peritoneum. (Specimen from H. A. Christian.)

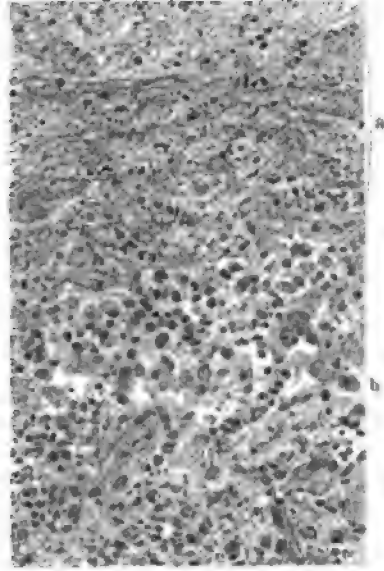


FIG. 85.—SECTION FROM BASE OF ULCER SEEN IN FIG. 84. MAGNIFIED 300 TIMES.

a, Necrotic tissue; b, large phagocytic cells infiltrating the submucosa.

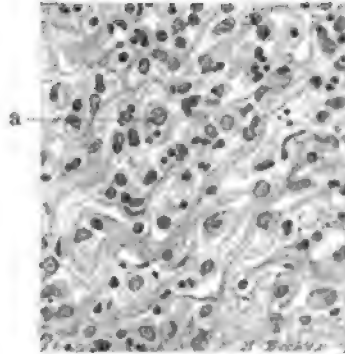


FIG. 86.—HIGHER MAGNIFICATION (350 TIMES) OF LARGE PHAGOCYTES (a).

appendicitis. The first appendix is 9 cm. long, 7 to 10 mm. in diameter, a slight constriction dividing the thickened middle portion into two parts. The surface is deeply injected and hemorrhagic, one point showing beginning necrosis. There are adhesions about the appendix. The mucous membrane lining the proximal third is swollen but smooth; farther out it is ulcerated, the necrosis extending at one point to the peritoneal surface. Microscopical examination of the cæcal portion shows

that the swelling of the mucosa is produced by the presence of an abundant infiltrate, chiefly consisting of large phagocytic cells which are seen in the lymph nodes and stroma. The mucous membrane of the rest of the appendix is studded with pin-head ulcers, almost all of which are situated in the chinks between the folds, and apparently have been produced by necrosis of the lymphoid follicles. This portion of the appendix also shows a diffuse purulent inflammatory process.

SIMPLE APPENDICITIS ARISING DURING THE COURSE OF TYPHOID FEVER.—In the reported cases there are no data given from which to determine the frequency of this class of cases, but *a priori* we should not expect it to be a rare event. In particular, where there are concretions, kinks or stenoses consequent upon an old inflammation, it seems very probable that the hyperæmia of the appendix accompanying the typhoid infection would have an important influence in precipitating an acute appendicitis. Histological examination of the appendix in such a case shows a simple inflammatory reaction and nothing suggestive of a typhoid infection. The second case sent by MACMONAGLE appears to be of this nature. The appendix is 5 cm. long, 7 mm. in diameter, with a slightly bulbous tip. The surface is injected and hemorrhagic and in places covered with a fibrinous exudate. The cæcal half of the canal is obstructed by a concretion 1×0.6 cm. Beyond this the mucosa is completely necrotic. Histological examination shows complete necrosis of the mucous membrane and purulent inflammation of all the tissues, involving the portion of the appendix distal to the part containing the concretion. The mucosa of the latter area is degenerated, but the other layers, apart from being thinned out, are not affected. There is no appearance of typhoid lesions.

Amœbic Dysentery.—The *Amœba coli* was discovered in the stools of infants and cholera patients by SAMBL and CUNNINGHAM, but LÖSCH first accurately described the disease in 1875. In America this amœba was first found by OSLER, in 1890.

An admirable description of the lesions produced in the infected tissues is given by L. ROGERS, of the Indian Medical service. These, at first, are small, pin-point elevations, reddish, with a yellowish centre. The earliest forms usually found are circular or oval ulcers, ranging from the size of a pea to an inch in length, the long axis of the ulcer running at right angles to the axis of the bowel. They appear as raised patches with well-defined thickened margins, often surrounded by a zone of congestion. The crater of the ulcer is filled with a characteristic, yellow, gelatinous material. A striking feature of the disease at this period is the healthiness of the bowel immediately beyond the ulcerated area. Later the ulcers lose their round or oval form and appear as long irregular ulcers, extending along the folds of mucosa, or as greatly thickened raised patches with light yellow or tawny ragged sloughs. Occasionally black sloughs form. In very chronic cases there may be some thickening of the bowel wall. Resolution proceeds by the gradual disappearance of the gelatinous material, the base of the ulcer becomes depressed and contracted, causing

a puckering of the still thickened margin, the defect is filled in by granulations, and finally a patch of scar tissue remains, which in many cases is pigmented. On microscopic examination there is found to be a notable absence of the products of purulent inflammation. According to FUTCHER, polymorphonuclear leucocytes are seldom found and never constitute purulent collections. The most striking feature is the enormous thickening

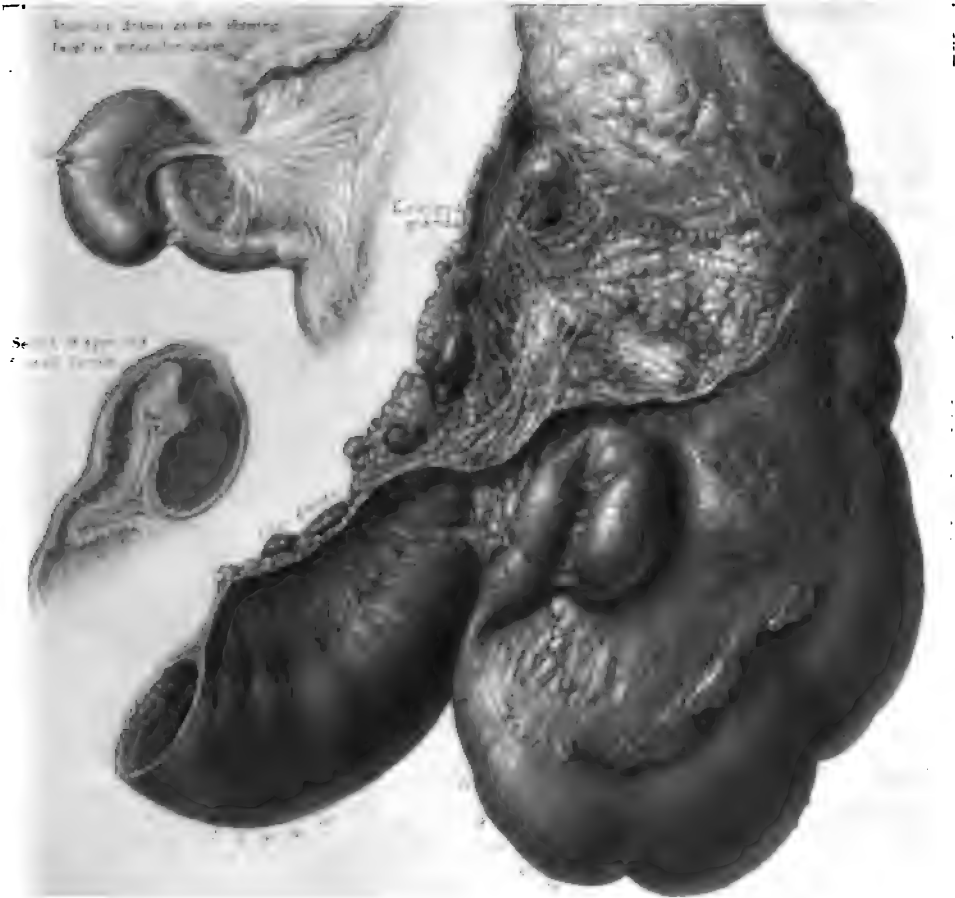


FIG. 87.—AMEBIC DYSENTERY.

The appendix bent at an acute angle and held in this position by firm adhesions. Almost complete obstruction of the canal at the angle, and the distal portion distended with yellowish gelatinous material. (Autopsy No. 2165.)

ing of the submucous coat, while, on the other hand, the mucous layer is but little altered. There is, first, an infiltration of the submucosa with yellow gelatinous material; a portion of the overlying mucosa then disappears, probably by a process of anæmic necrosis. The gelatinous material then forms the floor of the ulcer, the infiltration of the submucosa, however, extending considerably beyond the superficial denudation.

The lesions are most marked in the upper part of the large intestine and when the disease is slight the ulcers are usually limited to the cæcum and ascending colon. The vermiform appendix is often severely affected; just as in typhoid fever, perforation of the ulcer may occur. In a case illustrated in ROGERS's article, perforation of the appendix caused fatal peritonitis. In one case, recently observed at autopsy in Johns Hopkins Hospital (Fig. 87), the tip of the appendix was distended with the characteristic yellow, gelatinous exudate, and the mucosa of this part presented extensive areas of necrosis. The proximal half was but little altered. Histological examination of the distended portion showed a general hyperæmia of the mucosa and a considerable infiltration of round cells. A few polymorphonuclear cells were seen in places. At one point there was complete necrosis of the mucosa, slightly involving the submucosa. The submucosa was infiltrated with abundant round cells and a few polymorphonuclear leucocytes. The muscular coats were only slightly infiltrated, but in the peritoneum and mesentery the infiltration was marked. Amœbæ are found in the exudate at the margin of the ulcer, and at one point in a distended lymph space. A second case presented similar lesions in the appendix, chiefly involving the proximal half.

CHAPTER IX.

ETIOLOGY.

THE various factors uniting to call forth an attack of appendicitis may be considered under three headings: Predisposing, exciting, and final or essential.

PREDISPOSING CAUSES.

Predisposing causes may be local or general. Among the most important are the normal anatomic and physiologic conditions. The appendix consists of a blind sac of relatively great length and small calibre, possessing a narrow orifice; it resembles the tonsil in its abundant lymphoid tissue, and, like the latter, borders upon a cavity particularly rich in bacteria. The mechanical conditions are, therefore, such as favor the stagnation of ingesta and an increase in the virulence of the contained micro-organisms, while the presence of so many follicles affords a convenient portal of entry for bacteria. It is well known that the lymphoid tissues of the body are especially prone to infective processes, and the researches of STÖHR and RIBBERT show that the adenoid tissue of mucous membranes is easily accessible to infections from the surface. The analogies existing between the appendix and the tonsils, pointed out in 1876 by WATNEY, and later by SAHLI, SOUTHERLAND, RIBBERT, BECK, ADRIAN, and others, will be referred to again in considering the relation of appendicitis to general infectious diseases. Morbid anatomic conditions, resulting from a previous acute or chronic inflammation, are of recognized importance in the development of subsequent attacks. RIEDEL believes that all acute attacks are preceded by a chronic inflammation. Roux remarks that the *processionnal de l'appendicite* finds in the adenoid tissue and in the residual cicatrices parietal or peri-appendical, all the elements necessary to contract a new appendicitis on the occurrence of any physiologic hyperæmia, the result of indigestion, or of cold, or perhaps accompanying menstruation. These conditions, as well as their influence in rendering the appendix susceptible to recurrent attacks of inflammation, have been fully described in Chapter VI.

A similar *locus minoris resistentiæ* is created when the normal appendix becomes adherent to an adjacent structure, a frequent complication in pelvic inflammation, tumors, etc. I am acquainted with several instances in which an inflammatory process was apparently promoted by the attachment of the appendix to the site of a previous operation. (See Chap. XXI.) The influence of the floating right kidney as an etiologic factor in the development of appendicitis has been chiefly upheld by EDEBOHLS, who

would ascribe to it an important rôle in the etiology of the disease. He believes that the kidney acts as an exciting cause indirectly through disturbance of the circulation, owing to compression of the superior mesenteric vessels between the head of the pancreas and the spines of the vertebræ. C. BECK, on the other hand, believes that the kidneys act as a direct exciting cause, by pressure on the appendix itself. W. P. MANTON states that in his experience movable kidney is the most frequent cause of chronic appendicitis. Other writers have observed the occasional co-existence of the two affections, but do not consider that the relation of cause and effect is always clear. C. P. NOBLE, in 100 operations on cases of movable kidney, did not observe the association in more than six. Out of 104 cases of movable kidney operated upon at the Johns Hopkins Hospital the appendix presented evidence of chronic inflammation in four.

Age.—Appendicitis is distinctly a disease of early life. It is not rare in children (see Chap. XIV), but is most common between ten and thirty years of age. After this period there is a rapid decrease in the number of cases, although it is by no means rare even in advanced life. FITZ described a case in a man seventy-eight years of age. An analysis of the cases of acute appendicitis operated upon at the Johns Hopkins Hospital showed that 78 per cent. were under thirty years, about an equal number occurring in the second and third decades, and 5 per cent. in the first. The cases operated upon for chronic appendicitis for obvious reasons show a more advanced age. Thus, 44 per cent. occurred in the third decade and 23 per cent. in the fourth, while only 16 per cent. were under twenty years. The well-recognized susceptibility of lymphoid tissues to infections during early life is the probable explanation of the prevalence of appendicitis at this period. The more frequent dietary indiscretions and exposure to injury may have some bearing upon this point.

Sex.—The analysis of large numbers of cases demonstrates the greater liability of the male sex to appendical disease. The combined statistics of several authors give a percentage of 75 in males and 25 in females. The cases of the Munich Hospital reported by EINHORN were exceptional in presenting a larger percentage in women. In the Surgical Department of the Johns Hopkins Hospital the percentage in acute appendicitis is as 60 in the male to 40 in the female, but it is to be noticed at the same time that a number of cases were observed in the gynæcological service (see Chap. XXI). The striking difference in the two sexes is often erroneously explained by the supposed difference in the vascular supply of the organ, based on the mistaken view that in the female it receives a special branch from the ovarian artery. A really plausible explanation is found in the greater liability to exposure to injury and the greater tendency to errors in diet in the male sex. The excessive use of tobacco and the consequent digestive disturbances may also account for some cases. BYRON ROBINSON advances the theory that the relation of the appendix to the psoas muscle may explain the greater frequency of appendicitis in males. The psoas in them is longer, broader, and more developed generally, thus

offering a greater surface for contact with the appendix. This disparity is further increased by the shape of the pelvis, which is long and narrow. A. F. A. KING considers that bicycle riding by over-developing the psoas muscle subjects the appendix to excessive trauma and is thus a predisposing cause of appendicitis.

Nationality.—This is apparently an insignificant factor in the development of the disease. The great increase in the number of cases reported during the past few years is universal, and wherever the disease is carefully observed it is recognized as of common occurrence. The negro race, however, seems to be comparatively exempt from the affection. In order to obtain some information upon this point, I wrote to several surgeons practising in southern cities having a large proportion of negro inhabitants. The replies were unanimous in regard to the rarity of the disease in this race. S. C. BRIGGS, of Nashville, Tenn., out of several hundred operations for appendicitis could recall only one upon a negro. He stated, however, that, as the colored race in the South have their own physicians, they did not always come under the observation of others; nevertheless he thought that the disease was rare. H. J. INGE, of Mobile, Ala., out of 149 operations had but one in a negro, and by inquiry among other physicians found its occurrence in the race to be equally rare in their experience. G. H. NOBLE, of Atlanta, Ga., had never operated upon a negro for appendicitis. L. L. HILL, of Montgomery, Ala. (in the "black belt"), with a colored population of 9000, could collect the histories of only four cases that had occurred among them, and found that the physician who had been consultant for a number of years at Booker Washington's school, where there are about fourteen hundred colored students, did not remember ever to have seen a case there; at the Alabama Polytechnic Institute, however, twenty miles distant, where there are 400 boys, there was an annual average of eight cases. At the former school the diet is simple and the same for all, but at the latter the cadets live at different boarding-houses in the town. There are 800 negro prisoners at one of the Alabama coal-mines, and the physician in charge states that appendicitis is unknown among them. The explanation given for this relative exemption of the negro is that their diet is simple, they take a great deal of outdoor exercise, and they are free from digestive disturbances. The statistics of the Johns Hopkins Hospital show that, while the number of admissions of colored to white averages about 1 to 4, the number of cases operated upon for appendicitis is as 1 to 12.

Hereditary Influence.—LENNANDER (*Beit. z. klin. Med. u. Chir.*, 1895) characterizes appendicitis as a family disease, and most physicians of wide experience are impressed with the remarkable frequency of its occurrence in members of the same family. Brothers and sisters are affected more often than parent and child, although the latter association is not uncommon. F. FORCHHEIMER (*Amer. Med.*, Oct. 5, 1901) gives the statistics of three families which he had traced through several generations. In the first there were 25 members, 5 of whom had appendicitis, 4 of the cases

being relapsing in character, while one was operated upon after the first attack. In the second family there were 9 cases of appendicitis among 52 members (17 per cent.) and one case was fatal. Of the third family, 7 out of 22 members, or 33 per cent., had appendicitis, one case being purulent, 2 of the ordinary type, ending in resolution, and 4 relapsing cases. There was no mortality in the first and third families. A. McCOSH (*Amer. Jour. Med. Sci.*, May, 1897) reports three cases in three successive generations, and FINNEY (*personal communication*) had five cases in one family, the father, two sons, and two daughters being affected. In one of the Johns Hopkins Hospital cases a girl, twelve years of age, was operated on for acute appendicitis while her father was still in the ward convalescing after an operation, also performed during an acute attack. In several cases there was a history of one or more brothers and sisters similarly affected; in one instance two brothers of the patient had been operated upon for appendicitis in the Johns Hopkins Hospital—one four, the other two years previously. A family predisposition is explicable upon the ground of anatomic peculiarities and constitutional predisposition. It is well known that in some families there is a marked tendency toward affections of the lymphoid tissues. As a rule, the affection appears in the various members of the family at different periods, but there are a considerable number of observations referring to its development in two or more at the same time.

Instances of coincident attacks in members of the same family suggest the presence of a general infectious origin, and will be referred to later in that connection.

EXCITING CAUSES.

Disorders of Digestion.—These have the most important influence in determining an acute attack of appendicitis. In many cases there is a history of chronic constipation and indigestion. Sometimes an acute attack comes on shortly after a hearty meal of unsuitable food. Less frequently, diarrhoea, sometimes associated with symptoms of acute enterocolitis, precedes the onset of the appendical trouble. In the cases at the Johns Hopkins Hospital there was a history of constipation immediately preceding the attack in 43 per cent. In 50 per cent. the bowels were regular, but in many of these cases there was a history of indigestion, and it must always be remembered that the patient's statement that the bowels are regular is not a proof that there is no constipation. For example, in a recent case of J. C. BLOODGOOD's the patient asserted that her bowels were regular, but at operation the colon was found filled with scybalous masses, which were also present in the cæcum. In several instances the onset of the attack was marked by more or less severe diarrhoea, but this symptom was rarely present earlier and was frequently preceded by constipation. Frequently, as mentioned above, the attack may be directly traced to an indigestible meal. This was true in a considerable number of cases; in some of which the attack immediately followed the ingestion of unsuitable food, but usually occurred some hours afterward. A com-

mon history in the account of events immediately preceding the attack is that the patient had partaken of an unusually hearty supper and a few hours later was awakened from sound sleep by agonizing colicky pain in the abdomen, accompanied by vomiting.

Menstruation.—The intimate relation existing between the menstrual periods and appendicitis has been frequently noted, not only when the appendix is situated in the pelvis, but also when it is retrocæcal. The probable explanation lies in the fact that the congestion of the whole splanchnic area which accompanies the lowered blood-pressure of the peripheral circulation during menstruation creates a favorable soil for the activities of the micro-organisms contained in the appendix. I have observed this association in several instances, in some of which the recurrent appendical attacks invariably occurred at the menstrual period.

The subject is treated in some detail in my book "Medical Gynecology," 1908, p. 568.

Trauma.—Trauma is a direct factor in the causation of some cases of appendicitis, more often than has been supposed. Indirect injury, such as straining in heavy lifting, is a more common cause than a direct blow. In one of our cases the attack followed immediately upon a long, hard bicycle ride; in another the patient jumped from a street-car and was immediately seized with abdominal pain so severe that he could not straighten up. In another the patient had been in swimming for an hour when he was seized with a sharp, knife-like pain in the right side, which he attributed to cramp. The etiologic influence of injury is considered in detail in discussing the medico-legal aspects of appendicitis. (See Chap. XXV.)

Exposure to cold occasionally bears a direct relation to the development of an attack of appendicitis. It resembles in its action the physiologic congestions due to other causes, and is most liable to induce an acute attack in an appendix predisposed to inflammatory disease as the result of a previous attack.

Foreign Bodies and Concretions.—A few years ago the origin of appendicitis was frequently attributed to the influence of foreign bodies, the seeds of various fruits being most frequently described. Now, however, it is generally recognized that in the majority of cases appendicitis is not associated with the presence of foreign bodies or concretions; that true foreign bodies are comparatively rare; and that concretions, although present in a considerable number of cases, probably play a subsidiary rôle in the production of the disease. The frequency of foreign bodies in the appendix is indicated by the statistics of various recent observers. Thus, A. O. J. KELLY, examining 460 specimens, only once found a foreign body, which was a pin; HAWKINS found none in 67 fatal cases; BELL in about 1000 cases found five foreign bodies, a fish-bone, a core of apple, two pins, and a lumbricus; MURPHY found foreign bodies in 3.5 per cent.; while FITZ, writing in 1886, noticed their presence in 12 per cent. of the perforative cases, and MATTERSTOCK, in 1880, also found them in 12 per

cent. of his cases. In almost 1000 cases of appendicitis in the Johns Hopkins Hospital foreign bodies have been found in four cases, a segment of tapeworm, a mass of oxyurides in two, and a pin.

✓ CONCRETIONS.—Many of the seeds described in the older literature were undoubtedly merely fecal concretions, which frequently assume the appearance of a cherry or date stone and sometimes are recognized only by the most careful examination. The case shown in Fig. 88 is a good example of the simulation of a foreign body by a concretion. In size and shape the mass exactly corresponds to a hazelnut, and indeed the drawing was made under the impression that it was such. The presence of a fragment of nut-shell in the second concretion, together with the fact that the appendix was of the fetal type and would readily permit the entrance

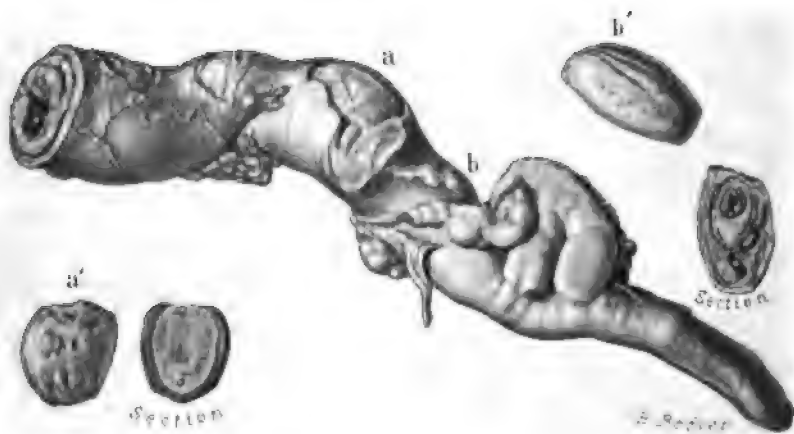


FIG. 88.—SUBACUTE APPENDICITIS ASSOCIATED WITH THE PRESENCE OF TWO CONCRETIONS.

The prominences a and b mark the site of the concretions (a' and b'). The former body bears a striking resemblance to a hazelnut, while a genuine fragment of nut-shell is embedded in the latter. (Specimen from the German Hospital, Philadelphia.)

of a comparatively large body, seemed to confirm this view, but the detection of extraneous material in the interior of the mass and its general structure showed that it was merely a concretion. Gall-stones, also, which formerly were supposed to enter the appendix frequently, are exceedingly rare; but they are often so closely simulated by enteroliths that a chemical analysis is necessary for their exclusion. The clinical evidence in some of these cases so strongly supports the gall-stone theory as to leave no doubt in the mind of the observer. A case in point, observed in the Surgical Department of the Johns Hopkins Hospital, is as follows:

L. F., age twenty-four. Admitted with a typical history of stones in the gall-bladder and in the common duct, and of their appearance in the stools. At operation about 100 small faceted calculi were removed from the gall-bladder. The patient was discharged well. About fourteen months later she returned complaining of sticking pain in the region

of the gall-bladder, which, however, was unlike the former attacks in character. This had been of a few days' duration and was accompanied with vomiting. Operation revealed a few adhesions about the gall-bladder and the omentum closely adherent to the chronically inflamed appendix. The removed appendix presented a stricture 1 cm. from the tip, and contained soft, tenacious fecal material which formed a mould of the whole lumen. Within it there were three hard, irregular bodies; the largest one, in the centre, was a cube about 1 cm. in diameter with faceted, slightly hollowed surfaces. It was dark brown in color, except for a superficial layer of white, corresponding to the appearance of the calculi removed from the gall-bladder at the first operation. The diagnosis was chronic appendicitis due to the presence of gall-stones. An analysis of the faceted stone made by L. MENDEL, of Harvard, showed that it was a typical enterolith. The nucleus was a small particle resembling a raspberry seed; the remainder consisted chiefly of calcium phosphate with some magnesium sulphate, traces of carbonate, some fat, and amorphous material.

A similar history was given by the patient from whom the appendix shown in Fig. 89 was removed, and the operator, DR. ROGERS, naturally made a diagnosis of gall-stones in the appendix.

GALL-STONES.—In Fig. 90 an appendix is shown which apparently contains a genuine gall-stone. The specimen, furnished by JAMES BELL, of Montreal, was removed from a young woman, twenty-two years old, on the second day of an acute attack. There was a history of an attack of appendicitis nine years before. The diagnosis of gall-stones was made from the appearance of the body and from its composition which consisted largely of cholesterin. In this case also the appendix had a wide orifice. In a similar case furnished by G. W. CRILE, of Cleveland, Ohio, the acutely inflamed appendix, which was short and funnel-shaped, contained a good-sized calculus, which chemical analysis showed to be a true gall-stone.

While, however, many observations owing to lack of careful examination are unreliable, in some instances foreign bodies undoubtedly gain access to the appendix and by their presence directly provoke the inflammatory process. Among the objects that have been found in the appendix may be mentioned pins, shot, pieces of lead, bones, hairs, bristles, various seeds, and enterozoa.

PINS.—The cases in the literature with especial reference to the occurrence of pins in the appendix have been carefully investigated by J. F. MITCHELL (*Johns Hopkins Hospital Bull.*, 1897, p. 35), who arrives at the following conclusions: "Foreign bodies are now known to play a much smaller rôle in appendicitis than that formerly accredited to them. The appendix would seem to act especially as a trap for pointed bodies and for small heavy objects like shot or bullets. Conspicuous among pointed bodies are pins, which are the commonest and at the same time the most dangerous of all foreign bodies." Bodies of light weight, like the classical grape-seeds and cherry-stones, are exceptional. The explanation of this fact is that, on account of their shape and weight, pointed or heavy bodies



FIG. 89.—APPENDIX CONTAINING ENTEROLITHS RESEMBLING GALL-STONES. (Specimen from Rogers.)

more readily become engaged in the appendical orifice and pass into the canal. It is a curious fact that pins rarely perforate the cæcum or small intestine. It is almost impossible for the seeds of cherries, dates, oranges, etc., to enter the lumen of the appendix, except in cases where the fetal



FIG. 90.—APPENDIX CONTAINING A CALCULUS, PROBABLY A GALL-STONE.

d. Horn.

type is preserved. Small seeds, such as those of berries, are not infrequent, and I have repeatedly demonstrated their presence under the microscope (see Fig. 91), but they are of no special significance in the etiology of appendicitis, as they merely form part of the fecal material commonly found in the appendix. My book, "The Vermiform Appendix and its Diseases," contains a list of 46 cases, taken from literature and from personal communications, where a pin was found in the appendix either at operation or at autopsy. These cases are sufficient to show the frequency of the occurrence of pins in the appendix, and no attempt had been made to collect the more recently reported instances. Among the 46 cases in my list there were only two in which the patients were seamstresses, a finding which we should hardly have expected, because, from a *priori*

considerations, we should expect pins to be swallowed oftener by those whose occupation leads them to hold them in the mouth.

SHOT OR BULLETS.—Of the heavy bodies which gain access to the appendix, the most common by far are shot or bullets. The earliest mention of these is by HEVIN (*Mém. de l'Acad. royale de chir.*, 1743, vol. I, p. 460): "A great quantity of shot are sometimes noticed collected in the intestines, especially in the cæcum and appendix, without having caused the slightest inconvenience." In my monograph will be found a list of cases in which the following foreign bodies, other than pins, were discovered in the appendix: a piece of bone, seven cases; the fin of a fish, two cases; a bristle of a brush and a two-inch nail, each one case. Since this list appeared, A. F. WHEAT, of Manchester, N. H. (*Amer. Med.*, 1906, vol. 11, p. 308), has reported the case of a woman, a factory operative, in whose appendix was found a die. The only point bearing on it was that the patient remembered having played with dice about two years previously.

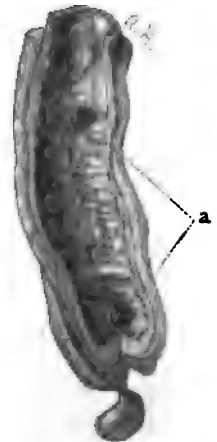


FIG. 91.—APPENDIX CONTAINING TWO SMALL SEEDS AT POINTS INDICATED BY a.

INTESTINAL PARASITES.—Recently considerable attention has been directed to the relation existing between intestinal parasites and appendicitis. It has long been known that enterozoa are not uncommon occupants of the appendix, and in numerous cases they have escaped through a perforation of the appendix into the peritoneal cavity. Their etiologic significance in the production of appendicitis is still under discussion. DUPALLIER (*Thèse de Paris*) believes that intestinal worms cannot perforate walls so resistant, especially if these are intact; at most they may enlarge an already existing perforation by their passage, or penetrate one just ready to appear. They can, however, act as foreign bodies and determine an ulcerative appendicitis.



FIG. 92.—APPENDIX CONTAINING A COMMON PIN. REMOVED BY F. B. LUND, BOSTON. CASE 40.



FIG. 93.—APPENDIX CONTAINING A BULLET.

The presence of the bullet (a) has produced deep ulceration on the opposite side of the canal (b).

VON MOTY (*Lancet*, 1902, vol. 2, p. 1211) attempts to make a distinction between the character of the lesions excited by the different varieties of parasites, and finds that lumbrici seem to be more often associated with gangrenous appendicitis, while the oxyuris and trichocephalus lead to chronic inflammatory conditions. Reference to the cases cited shows some confirmation of the view. While in many instances the association of lumbrici with perforation of the appendix may be a mere coincidence, it is readily seen that the mechanical influence of this parasite would be more deleterious to the appendix than that of the oxyuris and tapeworm, and therefore the liability to perforation and gangrene would be greater. The oxyuris is sometimes found in the normal appendix in large numbers and may cause attacks of severe spasmodic pain, simulating appendicitis. These cases have been carefully studied by

ARBORÉ-RALLY (*Arch. de méd. des enfants*, December, 1900) and by METCHNIKOFF (*Jour. des praticiens*, March 23, 1901), who have urged the careful examination of the stools for the worms or ova. Again, however, these parasites are found in the acutely inflamed appendix and possibly provoked the attack. They are most frequent in children. Thus ERDMANN, among 29 cases of acute appendicitis in children, in four instances found from 6 to 30 pin-worms in the appendix. The same writer has recently reported (*Med. Rec.*, 1907, vol. 71, p. 759) a statistical abstract of 100 cases of appendicitis in children operated upon in five years,

in which he found 10 cases of oxyuris in the appendix.

Ascaris Lumbricoides.—

Nine cases in which this worm was reported as being found in the appendix are cited in my monograph, p. 375. An additional case has been reported by J. C. HUBBARD ✓ (*Bost. Med. and Surg. Jour.*, Sept., 1903), which occurred in a patient sixteen years old, where there was general peritonitis. At partial autopsy a lumbricoid worm was found free in the peritoneal cavity and another half-way through a perforation in the appendix.

Oxyuris.—Eleven cases reported by eight persons are collected in my monograph, p. 376. To these should be added six cases reported by ERDMANN (*loc. cit.*) and a case reported by J. C. HUBBARD (*loc. cit.*) of general perito-



FIG. 94.—APPENDIX CONTAINING A LUMBRICUS. REMOVED BY C. F. BROWER.

nititis and death following perforation in a child nine years old, where two small worms were found in the appendix at the autopsy.

Other Parasites.—There are numerous instances on record in which worms of various kinds have been found in the inflamed appendix. HUNTER ROBB had a case of tapeworm in the appendix, METCHNIKOFF one of trichocephali, and SHOLLER and BIRSCH-HIRSCHFELD one of echinococcus. AIRETON relates a case of Bilharzia disease in which the eggs of the parasite were lodged exclusively in the appendix (*loc. cit.*, p. 377).

PATHOGENICITY OF FOREIGN BODIES AND CONCRETIONS.—The direct influence of pointed bodies in producing inflammation of the appendix is evident in some of the cases cited, but it is a remarkable fact that in

most instances, especially in the case of pins, there was proof that the foreign body had been present for a long period before this acute process developed, in many cases lying quiescent in the appendix until encrusted with calcareous material, and, finally, determining the site of a perforation, rather than inducing the acute inflammatory attack. In two cases the acute process was directly traceable to trauma, the foreign body, in one case a pin, being merely a predisposing factor. In another case there was a history of the pin having been swallowed a year previously to the acute attack, which was immediately induced by a kick on the abdomen.

In a case described by VÉRON (*Presse méd.*, 1902) the pin had been swallowed years before the first symptoms of appendicitis developed. The following case, observed in the clinic of W. H. HALSTED, shows how a large pin can harmlessly travel the alimentary canal, until finally ✓ entrapped by the appendix, when it becomes a dangerous object.

A negro boy, seven years of age, had a history of repeated attacks of abdominal pain referred to the right iliac region and accompanied by vomiting. Four days before admission he suffered from a feeling of distention, followed by cramps and vomiting. He was found lying upon his back, with his knees drawn up; the abdomen slightly distended, and the iliac region protected by his hands. Abdominal rigidity and spasm were limited to this region. The temperature was 103.2° F.; leucocytes 11,000. Operation disclosed a pathological anastomosis of the tip of the appendix with the ileum, through which a 4-inch pin had passed, producing perforation in the opposite side of the ileum, the head remaining in the appendix. The appendix was removed, both openings closed, and a gauze drain put in place. Early the following morning the child appeared to be doing well, when he suddenly became unconscious and died in a few minutes. Autopsy revealed no definite cause for death.

In the majority of instances, however, there is evidence that the foreign body excites a chronic inflammatory reaction which ultimately ✓ results in an acute process or leads to abscess formation. In one case a localized abscess was opened and drained, but death resulted from general peritonitis consequent upon the perforation of the abscess wall by a pin. A striking feature is the frequent association of abscess of the liver with the presence of a pin in the appendix. This was observed in 8 cases. In these cases, with one exception, the pin had evidently been contained in the appendix for a long time and had excited a chronic diffuse inflammation associated with a slight purulent process, a condition most favorable to the production of liver abscess.

Other sharp objects, such as pieces of bone and fish-fins, usually provoke the inflammatory attacks by producing abrasions of the mucosa and thus promoting the invasion of infective microbes.

The rôle of shot, bullets and similar bodies resembles that of concretions, which is purely passive or indirect. Such bodies may occasionally produce abrasions of the mucous membrane, but, as a rule, they act indirectly by obstructing the lumen, or by causing pressure anæmia of the appendix wall and diminishing the vitality of the tissue. These influences are often latent until brought into play by some accessory factor, usually a marked physiologic or traumatic congestion. The experiments of

✓ ROGER, BEAUSSÉNAT, ADRIAN, and others demonstrate that a smooth, rounded, foreign body in the healthy appendix has no influence in producing inflammatory changes and is usually soon expelled. HEVIN (*Mém. de l'Acad. royale de chir.*, 1743, vol. I, p. 460) called attention to the fact that a great quantity of shot is sometimes found collected in the intestine, especially in the cæcum and appendix, without causing the least inconvenience. In one instance 122 robin shot were found in the appendix of an old man who during life had had no symptoms referable to the appendix. Concretions are seldom or never found in the healthy appendix, but it is a generally accepted opinion that the chronic inflammatory changes usually present are the cause of the formation of the concretion and not the result of its presence.

Enterozoa have a twofold influence in the causation of appendicitis: a passive rôle, as in the case of enteroliths, and a direct effect by injuring the mucosa. The general view, as stated above, is that the parasite does not produce a perforation of the appendix, but merely profits by the rupture which results from a perforated ulcer. While, however, it is not probable that the parasites can penetrate the normal intestinal wall, it must not be forgotten, as emphasized by METCHNIKOFF, that they can produce erosions of the mucosa and inoculate it with the microbes with which they are covered. METCHNIKOFF cites a case of GIRARD's, who found two *trichocephali* in the appendix, the anterior part of one being buried in the depths of the mucosa.

FINAL CAUSES.

✓ The immediate cause of appendicitis is always microbic infection. The normal appendix contains in its canal the infective agents, which, innocuous in the healthy bowel, only wait the appearance of circumstances favorable to the exercise of their activities. The experiments of ROGER (*Les Maladies Infectieuses*), of KLECKI (*Ann. de l'Institut. Pasteur*, 1899), and others have shown that it is not necessary to introduce virulent bacteria into the appendix to produce an inflammation. The aseptic ligature of the bowel, forming a closed tube, and the consequent stagnation of the contents, increase the virulence of the contained micro-organisms, and when to this is added a slightly diminished resistance of the tissues, all the conditions necessary for an inflammatory outbreak are at hand. As already explained, a virtual *vase clos* is produced in the appendix under various circumstances. Moreover, it has been demonstrated by experiments that micro-organisms which are incapable of affecting healthy tissue easily invade tissue slightly altered by traumatism. But there are also cases in which there is no evidence of obstruction or of injury. The experiments of CHASTANET (*Thèse de Paris*, 1897) showed that appendicitis could be produced in the rabbit by making it swallow bacterial cultures. The appendix is affected to the same extent as the rest of the digestive tube, but with it repair seems less easy. BEAUSSÉNAT (*Rev. de gyn. et de chir. abdom.*, 1897) by feeding rabbits with contaminated meat produced a

severe intestinal catarrh and also found in the appendix swelling of the follicles, small abscesses in the mucous membrane, and infection of the organ. These changes were still present at a time when the other intestinal lesions had healed. He concludes from this that the vermiform appendix has a very slight tendency to a *restitutio ad integrum*. RECLUS (*Sem. méd.*, 1897, p. 237) believes that a propagated infection from the cæcum is answerable for a certain number of cases of appendicitis, explaining the sequence of events by the theory of stagnation and exalted bacterial virulence. Whereas in other portions of the canal the conditions are favorable for the healing of the inflammation, in the appendix, owing to its physical peculiarities, the inflammation is rendered more intense. NICOLAYSEN (*Zeit. f. Chir.*, 1903, p. 719), as a result of his experiments and from clinical observation, comes to the conclusion that appendicitis is primarily due to the extension of an infective enteritis. DIEULAFOY (*Bull. de l'Acad. de méd.*, Paris, 1904) believes that in associated suppurative cholecystitis and appendicitis the involvement of the appendix is secondary, and is due to descending infection. He strongly insists upon the importance of inquiry for antecedent gall-stones and of examining the gall-bladder in every case of appendicitis.

Appendicitis as a Local Expression of a General Infection.—The frequent association of appendicitis with rheumatism and other constitutional diseases, and the apparent occurrence of appendicitis in the form of small epidemics, have forcibly impressed many recent observers with the idea of the existence of an etiologic relationship between the general infections and inflammations of the appendix, some writers going to the extent of regarding all appendicitides as the local expression of a general infection; while others, again, noting chiefly its association with influenza, claim that "grip is the true cause of appendicitis." According to GOLUBOF (quoted from Adrian, *Mitt. a. d. Grenz. des Med. u. Chir.*, 1901, vol. 7, p. 407), on the other hand, inflammation of the appendix, in the majority of cases, is an infectious disease *sui generis*,—an affection which is peculiar to the appendix to the same degree as angina follicularis to the tonsils, and dysentery to the colon. RECLUS and others, while recognizing the influence of general infections, believe that appendicitis is not a disease one and indivisible, but is produced by various causes, some of a local, others of a more general character. In all cases the predisposing influences existing in the appendix are important. ✓

TRIPPIER and PAVIOT (*Sem. méd.*, 1899, p. 73) came to the conclusion that in appendicitis, as in the majority of intestinal lesions, a general infectious origin should be more frequently recognized. The association may be more or less remote, as the previous disease may have occasioned one or more attacks of latent appendicitis before giving place to an attack which manifests itself by the characteristic symptoms.

RELATION TO RHEUMATISM.—The etiologic relation between appendicitis and rheumatism was a matter of frequent comment by the older writers, and the theses which appeared on diseases of the right iliac fossa

between the years 1840 and 1860 are full of allusions to the connection between the two. The first suggestion of it in modern times, which has come to my notice, is that of SIR JAMES GRANT (*N. Y. Med. Rec.*, 1893, vol. 11, p. 609), who described a case in a girl of twelve, whose illness began with pain in the feet, followed in two days by a typical attack of appendicitis. Four days later she presented the signs of acute rheumatism with involvement of the shoulders and elbows. Since this publication numerous similar observations have appeared, that seem to show the existence of a definite relation between the two ailments. It is important to note, as emphasized by FINNEY and HAMBURGER (*Amer. Med.*, December 14, 1901), that the articular disease may precede as well as accompany or follow the appendical inflammation. The association of tonsillitis and appendicitis has also been established by numerous observations. The frequent connection of tonsillitis and rheumatic fever is now generally conceded. The tonsillar affection may precede the joint affection or may appear simultaneously with it. In explanation of many cases of appendicitis recent observers have emphasized the analogies existing between the appendix and the tonsils. These analogies relate not only to the anatomic peculiarities of the two structures, but also to their predisposition to inflammatory affection, especially at a youthful age. In one of FINNEY's three cases of appendicitis associated with rheumatism, there was a history of repeated attacks of rheumatism associated with tonsillitis, and finally of appendicitis associated with articular rheumatism and tonsillitis. In the surgical clinic of the Johns Hopkins Hospital, there were three instances, out of 91 cases of simple acute appendicitis, in which tonsillitis preceded by a few hours the onset of the appendical symptoms. The wider subject of the relation of appendicitis to the general infections was prominently brought forward by JALAGUIER, who observed the association of appendicitis with joint rheumatism and, later, of appendicitis following measles, mumps, scarlet fever, typhoid fever, and chicken-pox. Animal experimentation has demonstrated that the lymphoid tissue of the appendix is the seat of choice for the localization of infective organisms derived from the general circulation. ADRIAN succeeded in producing appendicitis by injecting suspensions of bacteria into the ear vein of the rabbit. In these experiments microscopic lesions were constantly demonstrable in the mucosa of the appendix before either gross or histologic changes could be detected in other portions of the intestine.

RELATION TO INFLUENZA.—The experimental proof of the susceptibility of the appendix to become the seat of a localized process in general infections makes us more ready to accept the clinical evidence. The most frequent examples are found in the association of influenza and appendicitis. In all large epidemics it is repeatedly observed that the intestine is more or less seriously injured; indeed, as OSLER remarks, the brunt of the catarrhal affection may fall upon the gastro-intestinal mucous membrane. It should not, therefore, be a matter of surprise if in the appendix, which is already prepared, a more severe process frequently arises. During the

late epidemics of *la grippe* an increase in the number of cases of appendicitis and a frequent connection between the two diseases has been noticed by many careful observers. FINNEY (*loc. cit.*) observed an increase in the frequency of appendicitis during a recent epidemic and a close relation existing between the two ailments. In at least six instances the appendical inflammation appeared during or soon after an attack. SONNENBURG considers it to be an established fact that during an epidemic of *la grippe* inflammation of the appendix is much more frequent.

ABBÉ (*personal communication*) has seen some cases of appendicitis occasioned by influenza in which the affection seemed concentrated in the appendix, producing acute inflammation with follicular ulcers and some hemorrhage. The swelling of the regional lymph glands is characteristic.

A further evidence of the relation of the appendicitis to a general infection is its frequent occurrence in epidemic form. F. FRANKE mentions three cases of appendicitis in three brothers at one time; the relation between the affection and a then prevalent epidemic of influenza could not positively be established. In other instances, although there was no direct evidence of the relation of the appendical inflammation to a specific infectious disease, the simultaneous appearance in two or more members of the same family was very suggestive of a general infectious origin.

RELATION TO VARIOLOID, SCARLATINA, ETC.—LEUDET (*Arch. gén. de méd.*, 1859, vol. 104, pp. 137-316) describes cases of perforative appendicitis accompanying varioloid. The association of appendicitis with scarlet fever has also been frequently observed. An interesting example recently communicated to me is as follows: A boy, eight years old, was taken ill with a severe attack of scarlet fever accompanied by abscess of the neck glands, and three weeks later was operated on for acute appendicitis. TURK, while attending this case, developed an erysipelatous throat, supposed to be scarlet fever, and fourteen days later had an acute attack of appendicitis associated with exudate. Blood from TURK was injected into a rabbit, and on its death, streptococci were obtained from the heart's blood.

RELATION TO MEASLES.—Dr. T. R. WRIGHT, of Augusta, Georgia, has reported (*personal communication*) a case of well defined appendicitis which developed during an attack of measles. After four days the patient was operated upon and an abscess with spreading peritonitis was found. Death occurred on the third day after the operation, from pneumonia.

POLJAKOW (*Cent. f. Chir.*, 1902, p. 206) observed a case of simultaneous appendicitis and pneumonia due to the presence of the staphylococcus. The appendicitis improved after six or seven days, leaving a finger-thick infiltration. The pneumonia ended by crisis on the ninth day.

Another argument in favor of this connection in some cases of appendicitis is the occurrence of marked constitutional disturbances preceding the appearance of local symptoms. In several of our cases one or two days' illness characterized by headache and general malaise preceded the onset of abdominal symptoms. In one case in a girl of fifteen, the illness began with pain in the chest and back, malaise, and slight cough. She slept

poorly, and the next day felt too ill to get up, was feverish and had no appetite. Later in the day pain began in the right iliac fossa and a typical case of appendicitis developed. In another case there was pain in the back and head; and in still another, backache was present for one or two days before the onset of local symptoms.

These clinical observations and the *a priori* evidence derived from animal experimentation do not, however, warrant any positive deduction regarding the existence of a causal relationship between the general infection and inflammation of the appendix, and in the absence of bacteriological demonstration such deductions are open to criticism. In frequent instances the *pneumococcus* has been stated to be the peccant microbe, but so far as I can find, these observations all lack the demonstration of the capsule, and in the absence of this it is well known how easily this organism is confused with the *streptococcus*. ADRIAN claims to have demonstrated the *influenza bacillus* in a peri-appendical abscess following an attack of *la grippe*, but unfortunately no description of the morphological and cultural properties of the organism are given. Further investigation along these lines will doubtless reveal the true facts of the case. To sum up, I would say that:

1. A previous inflammation renders the appendix susceptible to further attacks.
2. The most important cause of appendicitis is digestive disturbance.
3. Acute or chronic enterocolitis may be occasionally an exciting cause.
4. Enteroliths and foreign bodies usually play a passive rôle. Pointed bodies and enterozoa may be direct exciting causes.
5. The clinical evidence is in favor of an intimate relation between appendicitis and rheumatic fever.
6. Animal experimentation and clinical demonstration make it plain that general infection is frequently the exciting cause of acute appendicitis.
7. It is not yet determined whether the general infection merely acts as an exciting factor by preparing a suitable soil for the activities of the intestinal bacteria, or whether the specific micro-organism is the direct cause of inflammation of the appendix.

CHAPTER X.

CLINICAL HISTORY.

Introductory.—Any attempt at describing the symptomatology of appendicitis must be preceded by the statement that any or even most of its characteristic symptoms may be absent in the beginning of any given case, or even throughout its entire course; and that the clinical phenomena of the disease are not a reliable criterion of the pathological changes in progress, as symptoms of the most pronounced character accompanying certain lesions in one case may fail to appear with them in another. S. W. GAY characterizes appendicitis as the most treacherous of known diseases, insidious in its manifestations, uncertain in its career, and liable to sudden changes which at any moment may put the patient in a condition of extreme peril. It is a matter of common experience to find a mild attack which is apparently subsiding, develop symptoms of the gravest significance; while, in other instances, the most ominous symptoms are sometimes followed by a speedy recovery. The wider the experience of the surgeon in dealing with the protean forms of this disease, the less confidence will he have in formulating any definite conclusions regarding the interpretation of its individual symptoms, and particularly concerning their prognostic value. But, although this fact should always be borne in mind, it must be added that with few exceptions appendicitis ought always to be recognized, and we may accept with little reserve the dictum of DIEULAFOY that "no one should die of appendicitis." Moreover, the association of certain symptoms and their preceding history produce a definite clinical picture in the presence of which it is justifiable to assume the existence of certain lesions; and while it is rarely safe to foretell the future course of events from the symptoms present at any single stage of the attack, it may be possible to express with some assurance an opinion regarding the outcome of the disease if immediately arrested by operation. Thus, in the majority of cases, it is possible to determine the existence of acute or chronic appendicitis, and the presence or absence of abscess formation, or of a diffuse or generalized peritonitis; but there is no symptom-complex from which we can determine the exact amount of injury under which the appendix itself is laboring, nor recognize whether perforation is impending or a purulent peri-appendicitis being successfully walled in. Allowing for uncertainty due to these facts, we may divide appendicitis for clinical purposes into two classes—*acute* and *chronic*; and these may be more explicitly considered according to the presence or absence of suppurative peri-appendicitis, of general peritonitis, or of remote metastatic infections.

SYMPTOMS OF ACUTE APPENDICITIS.

Acute appendicitis may have a sudden onset; or it may be insidious in character, being ushered in with symptoms of moderate severity which steadily grow worse; or it may possibly exhibit occasional remissions. In a number of cases a feeling of general malaise precedes the onset of the attack. The early symptoms may include pain, tenderness, rigidity, muscle spasm, nausea, vomiting, and constitutional disturbance; distention and tumor may also be present. The time at which these symptoms appear, however, is variable, and some of them may never occur at all. The most constant, most characteristic, and most important symptoms of all are pain and rigidity.

Pain.—This symptom is always present at some stage of the disease, although it is occasionally very evanescent. Sometimes suddenly, or sometimes gradually, the patient is seized with sharp cramp-like pains in the abdomen. The attack of pain may come on as suddenly as if the patient were shot, as in a case described by J. D. BRYANT, where a lieutenant, when feeling perfectly well, was seized with a sudden pain in the right inguinal region so severe that he could not move. PONCET relates a similar case in a soldier, who described the attack as "like the shot of a gun." In one case in the Johns Hopkins Hospital, a man, aged twenty, was at work when seized with abdominal pain so sudden and severe as to cause him to fall to the ground, and in another instance the patient fainted at the first attack of the pain. A sudden onset with acute abdominal pain, the patient being habitually in good health, was noticed in 43 per cent. of the cases admitted to the Johns Hopkins Hospital. Of the remaining cases, some began with slight symptoms gradually increasing in severity, but in a considerable number the onset of acute symptoms was preceded by two or three days of lassitude and headache or slight digestive disturbance. The initial pain may be located in the right lower abdomen, but is commonly referred to some other region. In about one-third of the cases at the Johns Hopkins Hospital the pain began in the right iliac fossa. In 20 per cent. there was no definite localization, the pain radiating through the whole abdomen. The second most frequent location was in the umbilical region, and in somewhat fewer cases the primary pain was in the epigastrium. In one case the attack began with pain immediately to the left of the epigastric region; again it was referred to the right hypochondrium; and in two or three instances pain in the back was the earliest symptom. In one instance the patient complained of pain in the right testicle for two days before it extended to the inguinal region. At the onset the pain is paroxysmal, cramp-like, and radiating. It is exceedingly severe, sometimes indeed agonizing, and the patient may not be able to straighten up or stand during the paroxysms. There may be complete freedom from pain in the intervals, but, as a rule, a feeling of soreness persists. The paroxysmal character of the pain lasts from one to several hours, and in

some instances continues throughout the attack; but sometimes after the first onset there is a cessation of this pain for several hours or even as much as a day. In some cases the pain at first is slight and indefinite, and then gradually increases in severity. It may begin as a vague, cramp-like sensation, or as a diffuse soreness increasing in intensity, and finally settling in the right iliac fossa. After a few hours the pain almost always becomes localized in the right lower abdomen, and, as a rule, assumes a different character, becoming less intense but more continuous. Often, however, acute exacerbations may be brought on by movement, especially movement involving the psoas muscle. Hence the patient lies in the dorsal position, and often with the legs flexed, in order to favor the right side. The pain is also aggravated by the passage of flatus, by coughing, or by deep respirations. The site of this later pain varies according to the position of the appendix. The greatest suffering, however, is usually referred to the iliac fossa. It may be confined to a very small area, or it may be diffuse, extending into the groin, the lumbar region, or toward the median line. In the case of an ascending retrocaecal appendix, the pain may centre in the right hypochondrium, or in the posterior lumbar region, sometimes radiating towards the scapula. In one case in which this particular localization of the pain was noticed, the tip of the appendix was found in close proximity to the base of the gall-bladder and a few fine adhesions surrounded the cystic duct. In a second case, the appendix was surrounded by an inflammatory exudate and a tag of omentum was adherent to the gall-bladder. At other times the chief pain is felt in the hypogastric or pelvic regions, in which case the appendix is usually found lodged in the pelvis, or else an abscess has formed there.

Bladder and rectal symptoms are common, and thoracic pain is not infrequent. The latter is sometimes due to a true pleuritis, which, according to WOLBRECHT (quoted by Sonnenburg), is a frequent accompaniment of appendicitis. In many instances, however, it is a purely reflex phenomenon, readily explained by the close anatomic connection between the abdominal wall and the pleura, through the intercostal nerves. In some cases the pain is not at any time referred to the region of the appendix, but remains more or less diffuse or is confined to the seat of the initial pain. GAY, in relating his own case, states that in every attack the pain was definitely limited to the epigastrium. There is some discussion as to whether pain in appendicitis ever occurs without involvement of the neighboring peritoneum, and whether it is always inflammatory or whether it may be functional in origin. The experiments of LENNANDER (*loc. cit.*) confirmed by the clinical observations of CUSHING, MITCHELL, and others, have demonstrated the absence of sensory nerves in the viscera and visceral peritoneum, but have shown that the parietal peritoneum is exceedingly sensitive to pain impressions, the very slightest traction causing acute suffering. They have proved that the appendix may be lifted up, may be compressed between forceps, and may even be excised, without pain; the mesentery also may be

ligated without the knowledge of the patient, if due care is observed not to disturb its relations; but it has been experimentally demonstrated that if the slightest traction is brought to bear upon the appendix or mes-appendix, exquisite pain is experienced. "When the ileum and ascending colon have a common free mesentery, the discomfort and pain from appendicitis are felt in the pit of the stomach, or in the para-umbilical region, which is the segmental area corresponding to the point of origin of this portion of the mesentery. In healthy individuals there is no sensation during the process of digestion, and intestinal tumors may progress without pain until perforation and peritonitis occur. Strong intestinal peristalsis may produce only a sensation of rumbling, but when the parts of the intestine which have no mesentery, or those fixed to the parietes by peritoneal reduplication or adhesions, are over-distended, there will be tension upon the nerves in the subserosa, and each contraction will cause colicky pains." The initial colicky pain in appendicitis is partly explained by the assumption that the primary inflammatory reaction excites abnormal peristaltic contractions, but is probably due to the distention with flatus of the inflamed cæcal area, and it is often relieved by the passage of flatus.

The secondary localization of the pain is due to involvement of the neighboring parietal peritoneum. The appendix is adherent to some point, or the peritoneum is inflamed, or there is a lymphangitis or lymphadenitis caused by the infective microbes or their toxic products. LENNANDER believes that possibly the toxic substances from the diseased appendix may cause pain by a direct chemical action upon the cerebrospinal nerves. This pain lessens in intensity after a few hours, and in simple cases usually ceases in from twenty-four to forty-eight. Occasionally, it is very evanescent, disappearing in two or three hours. An increase in the local infection is usually marked by the continuance of the pain, which also becomes more intense. A sudden sharp pain after a temporary subsidence often means a perforation or a beginning general infection. A sudden lull in the local symptoms, not accompanied with a corresponding improvement in the general condition ("*accalmies traittresses*"), is an ominous symptom, and usually indicates gangrene, the rupture of a pus sac, or an unusually virulent infection. If the pain again becomes generalized, a spreading infection of the peritoneum may be suspected. General toxæmia, on the other hand, is often marked by the complete cessation of all pain.

Tenderness.—Tenderness on pressure possesses a significance of such great value that the surgeon hesitates to make a diagnosis of appendicitis in its absence; nevertheless it is a symptom which must be estimated with considerable caution and with due allowance for the temperament of the individual. It is easily exaggerated by neurotic patients, but, as pointed out by M. H. RICHARDSON, exquisite tenderness is not easily feigned, and, if the patient's attention is diverted, can be accurately gauged. It is a particularly important sign, in that it usually persists after spontaneous pain has ceased, and is present so long as an active inflammatory

reaction is going on. A good example of this latter fact is afforded by the following case from the surgical clinic of the Johns Hopkins Hospital. The patient had gone to bed in his usual health, but on rising he was seized with colicky pain distributed over the whole abdomen, accompanied with nausea and a slight chill. In two hours the pain became localized in the right iliac region. At the end of seven hours after the onset the pain entirely ceased and did not return. When admitted, eleven hours after the beginning of the illness, there was a slight elevation of temperature and pulse and the abdomen, although not distended, manifested slight tenderness over the whole right lower quadrant and exquisite tenderness over McBurney's point, associated with localized rigidity and muscle spasm. There was a leucocytosis of 34,000. Operation revealed an acutely inflamed appendix, adherent by its tip and covered with flakes of fibrin. The point of greatest tenderness often corresponds exactly with McBurney's point, but frequently the most sensitive spot is a little above, or below, or to the inner or outer side of this area. It corresponds to the site of the appendix and is most marked over the diseased portion. For example, E. POND (*Med. Rec.*, 1898), in the case of a boy twelve years old, found slight rigidity of the right rectus muscle, more marked in its upper half. There was but slight pain on deep pressure in the iliac region, but in the posterior and outer part of the abdomen there was a swelling with extreme rigidity of the muscles, and at a point 2 cm. below the kidney, a spot which was "as sore as a boil." At operation the point of the gangrenous appendix was found in a position exactly corresponding to the sensitive spot. Sometimes there is tenderness on pressure in the left side of the abdomen, but this is usually accompanied with more intense pain referred to the region of the appendix. This reflex pain is often an indication of peritoneal irritation. It is not unusual to find that the pain is not felt while pressure is being brought to bear upon the abdomen, but that on removing the hand sharp pain ensues. If the appendix occupies the pelvic position, tenderness is sometimes only detected upon rectal or vaginal examination. Cutaneous hyperaesthesia is regarded by BLOS (*Beit. z. klin. Chir.*, vol. 32, p. 420) as a symptom of great importance. Where cutaneous hyperaesthesia, muscular rigidity, and localized or general pain are present, peritonitis will always be found. It is sometimes exceedingly vivid, making further palpation impossible.

Rigidity.—Next to pain, rigidity is the most reliable early sign of acute inflammation of the appendix. At the outset it is general, but soon after the localization of the infection it becomes limited to the right side. General rigidity is difficult to estimate, for it is often voluntary, and is commonly found with simple intestinal colic. Unilateral rigidity, on the other hand, is readily detected, is not easily assumed, and is a definite indication of underlying mischief. Still more conspicuous is rigidity limited to a small area. The value of this symptom is thus tersely expressed by RICHARDSON: "Rigidity with distinctly localized pain strongly suggests appendicitis,

with fever it almost proves it, with tumor it fully establishes the diagnosis." While, however, of great positive value and almost constantly to be found during the first stages of an attack, it sometimes disappears early, and in the most serious conditions may be entirely wanting or so slight as to be scarcely recognizable. This is particularly true in the presence of gangrene, where local tenderness and rigidity may both fail, and also in many cases of perforative appendicitis, where rigidity is so slight and transient as to escape observation. On the other hand, there may be pronounced localized rigidity in the presence of very mild inflammatory processes. The muscular tension is sometimes so pronounced as completely to mask a tumor mass beneath. As a rule, the tension diminishes as the active inflammatory process subsides and the abdomen becomes soft. If a mass is present, its outlines are then clearly perceptible. Increasing severity of the local infection, or the beginning of a diffuse peritonitis is marked by the return and increase of the muscular tension, and in extensive peritonitis the abdomen usually becomes uniformly distended, rigid, and motionless. In some cases, however, the abdomen is soft and natural in appearance, even in the presence of generalized peritonitis.

Muscle Spasm.—This symptom is less constant than rigidity, but it is observed in the majority of cases during the early stages of the attack, and its presence is a certain sign of an inflammatory process. It is a wholly involuntary reaction on the part of the muscle, and is best detected by light palpation. The most active muscle spasm is obtained when the appendix is in close relation with the abdominal parietes, and when peritoneal infection is beginning. In early diffuse peritonitis, active muscle spasm may sometimes be found all over the abdomen.

Pain, tenderness, and rigidity are rightly called the cardinal symptoms of appendicitis, and they demand the first and most careful consideration. There are, however, other symptoms, of fairly constant occurrence, which may have a positive value. The most noteworthy of these are gastro-intestinal disturbance, elevation of temperature, and altered pulse-rate. General constitutional symptoms also are often of great significance; and, as pointed out by FEDERMANN in describing peritonitis, the general impression obtained at the first sight of the patient is to the experienced observer of the greatest importance, and often leads to a diagnosis when other signs are doubtful.

Pulse.—The pulse is of greater importance than the temperature as an indication of the condition of the patient, and as a guide to prognosis; and more especially the relation of the pulse-rate to the temperature. A very rapid pulse is always a grave symptom, and a rapid pulse out of proportion to the amount of fever usually presages a fatal termination. In the majority of the cases of acute appendicitis the pulse-rate is affected early, and while an active process is going on, continues slightly accelerated, even with a normal temperature, but this is by no means a constant symptom; on the other hand, in nervous individuals and children the pulse

is quickened even with simple functional disturbances. As the affection becomes localized and the active process declines, the pulse becomes normal. The development of the localized suppurative process is generally accompanied by an accelerated pulse-rate, corresponding to the rise in temperature; but when the abscess is finally limited and absorption diminished, the pulse and temperature are normal. With a spreading peritonitis and beginning meteorism, the pulse is rapid, full, and of high tension, the higher tension depending, according to LENNANDER, upon the increased intra-abdominal tension, and the contraction of the abdominal muscles. As the infection progresses the resulting general intoxication causes paralysis of the inhibiting centre, and at the same time directly affects the heart's action, consequently the pulse becomes rapid, weak and irregular. The prognosis in such a case is exceedingly grave, and if associated with a falling temperature is practically hopeless. A slow pulse of poor quality may also indicate impending dissolution. A good pulse, on the other hand, may exist in the presence of a fatal infection, and by itself can never be relied upon as a guide to prognosis or diagnosis.

Temperature.—The temperature varies extremely in different cases. It may be very high in the beginning, but subside as rapidly as it arose; or there may be a gradual rise, reaching the maximum in thirty-six or forty-eight hours; while in other cases, again, the evolution of the disease may be almost apyretic throughout, even when associated with the development of a large abscess, or in the presence of a hopeless general peritonitis. Taken by itself, the temperature is most unreliable and misleading, but in connection with other symptoms, and at certain stages of the attack, it may be of value in showing the progress of the infection. In ordinary cases the temperature is rarely high, often not going above 100° F., and seldom above 103° F. In a general way, when associated with other slight symptoms, a low temperature indicates a mild inflammatory process and a high temperature a more serious infection. But too much stress should not be laid upon this sign, as it is often deceptive. In a recent case at the Johns Hopkins Hospital, a young man walked into the hospital with a temperature of 99.4°, pulse 112; he looked bright, and complained only of slight soreness in the right side. The attack had begun after breakfast the preceding morning with pain in the epigastrium, radiating over the abdomen. After an hour or two the pain became localized in the right iliac fossa, but subsided at the end of three hours and did not return until night. He vomited once, after taking castor oil, and his bowels moved freely. There was no further vomiting and no nausea. Abdominal examination was negative, except for slight rigidity on the right side and slight pain on deep pressure over the region of the appendix. There was, however, a leucocytosis of 26,000, and, notwithstanding the low temperature and absence of marked symptoms, FINNEY decided upon immediate operation. The peritoneal cavity was found to contain free turbid fluid and the appendix was immensely swollen, distended with pus, and apparently on the point of rupture. The mucous membrane was gangrenous. Recovery was uninterrupted.

In another case the patient, a medical student, aged twenty-five years, was awakened with sharp abdominal pain, chiefly to the left of the epigastrium. The pain soon wore off and the patient went to sleep. In the morning there was diarrhoea, relieved, however, with paregoric. He vomited once in the morning and again in the evening. The next morning he felt better until after breakfast, when there was a slight return of pain, and during the day there was considerable tenderness. In the evening he walked to the hospital for advice. His temperature was then 99.2° F., his pulse 100; there was considerable tenderness in the right iliac fossa, and slight distention. Immediate operation showed the appendix distended, and covered with fibrin; there was a gangrenous patch at the base, and another, 6 cm. distant, which was perforated. The peritoneal cavity contained some cloudy fluid. Recovery.

In some instances a simple catarrhal appendicitis is accompanied with a temperature ranging from 103° to 104° F. A persistent high temperature, or a renewed elevation of it after the patient has begun to improve, is of great significance. A temperature continuously high from the outset usually indicates a severe infection with local or metastatic extension or with general intoxication. For example, a child at the Johns Hopkins Hospital, aged four years, was seized after a hearty dinner with violent abdominal cramp, lasting some hours. She passed a comfortable night, however, and in the morning felt well, but her temperature was 104° F. and her pulse 160. At 10 A. M. the abdominal pain returned and grew steadily worse; the abdomen seemed slightly swollen and tender, and the temperature was 105° F. A diagnosis of entero-colitis was made and an oil enema given. During the night the bowels moved three times and she vomited once. The next morning paroxysmal pain continued, referred by the child to the epigastric region. She lay with her knees drawn up. The abdomen was swollen and tender, especially in the right ileocaecal and lumbar regions; the tongue was dry and coated, the temperature 104° F., and the pulse 140, the leucocytes 32,000. Operation revealed a general septic peritonitis. The appendix showed an acute hemorrhagic inflammation with slight necrosis of the mucosa. Death occurred before the incision was closed.

On the other hand, a general peritonitis may develop with practically no elevation of temperature. For instance, a man was admitted to the Johns Hopkins Hospital in 1891, with a history of pain beginning the preceding morning, at first localized in the right iliac region but later becoming general, and continuing until night, when it was relieved by morphine. Nausea was almost constant and there was frequent vomiting. The bowels moved after an enema. On admission there was present moderate tympanites with general tenderness, most marked in the right iliac region. Temperature 99° F., pulse 88. Frequent vomiting. The next day he was more comfortable, the abdomen not so sensitive, the nausea and vomiting diminished and the pulse and temperature normal. He passed a comfortable night. At operation the following morning the

appendix showed beginning gangrene and there was a general purulent peritonitis. Death took place on the third day.

An encapsulated abscess is usually accompanied by a continuous elevation of temperature with daily remissions, present from the outset or beginning a few days after the initial symptoms. A persistent fever without evidence of a general infection is a fairly certain indication of the presence of a focus of suppuration. However, after the active process has subsided a very large abscess may exist with a normal temperature. In other complications, such as abscess of the liver, septic phlebitis, or pyæmia, the temperature is usually high, and sometimes remittent or even intermittent and of the characteristic hectic type.

LENNANDER (*Beit. z. klin. Med. u. Chir.*, 1895) calls attention to the importance of observing the variations in the relation between the axillary and rectal temperatures. With early abscess formation and in spreading abdominal infection the difference is sometimes once or twice greater than normal. In very ill patients this difference is sometimes marked, and may be due to the influence of a neighboring inflammatory mass, but very often it is a sign of collapse in which there is a fall of temperature on the surface of the body and a rise in its interior.

Chills are exceptional in cases of simple diffuse inflammation, but are not rare with more severe lesions. Of the cases of acute appendicitis not associated with abscess or general peritonitis admitted to the Johns Hopkins Hospital, 15 per cent. gave a history of chills, and in all of these, with two exceptions, the appendix was gangrenous, perforated, or distended with pus. In the two cases showing slight lesions there were merely chilly sensations, which in one were probably accounted for by the presence of oxyurides associated with high temperature. In three cases the chill occurred at the onset of the attack; in one the patient, who had gone to bed well, was awakened with a severe chill. More frequently, the chill occurred several hours or a day or two after the onset. About 50 per cent. of the cases of diffuse or generalized peritonitis experienced chills, occurring in some instances at the onset of the appendicitis, in others with the beginning of symptoms of peritonitis. A limited number of the cases associated with circumscribed abscess gave a history of chills, sometimes occurring at the onset, or again after the third or fourth day. Repeated chills occurring late in the course of the malady generally indicate a dissemination of the pyæmic process.

Tumor.—A mass is rarely recognizable in the early stages of acute appendicitis, and is not present at any time in cases of the mildest type, nor, as a rule, in the most severe forms. The presence of a circumscribed swelling is an indication on the one hand of the extension of the disease beyond the appendix, and on the other hand of a distinct tendency toward its limitation. The inflamed appendix itself, apart from the surrounding exudate, is seldom palpable, and even when considerably swollen the rigidity of the overlying muscle during the early acute stages affectually conceals it. As the affection subsides and rigidity diminishes, it is some-

times possible to outline the exquisitely tender, distended appendix, but very frequently it is so deeply situated that even when the abdominal walls are relaxed under an anæsthetic it is not easily discovered. Often when the appendix is supposed to have been palpated, at operation it is found in a different and quite inaccessible position, the mass felt being probably contracted muscle. In some instances, however, a definitely outlined tumor is detected even at the very outset of the attack. With few exceptions this proves to be the thickened œdematous omentum which has wrapped itself around the appendix, or is attached by a recent exudation to the most acutely inflamed portion of it. If seen early, this omental tumor is more or less freely movable, and appears as a cylindrical or pear-shaped mass about the size of a fist. Later, it is apt to become adherent to the surrounding structures.

An extensive fibrinous or purulent exudation is occasionally discovered shortly after the apparent onset of the attack, but in most instances these are probably cases of insidious evolution in which the first acute symptoms are in reality due to the development of the extra-appendical process. In such cases a large abscess containing a pint or more of pus may be discovered within the first twenty-four hours. Acute inflammation of the appendix persisting for more than three or four days usually results in the involvement of the surrounding tissues, and is associated with a more or less abundant exudate, having a clearly defined tumor mass. The character of the exudation, and hence the physical peculiarities of the mass, vary considerably. In some instances the tumor may consist wholly of a massive fibrinous or sero-fibrinous exudate, which appears as an irregular, dense, immovable thickening. In other cases there is a dense fibrinous mass containing a small focus of pus or, again, a large, fluctuant abscess develops which is usually globular and prominent, forming a plainly visible swelling in the right abdomen. A purulent exudate is often accompanied by more or less œdema and infiltration of the overlying integument. The inflammatory mass, as a rule, is perfectly immovable, but it may possess slight mobility, and in some instances—for example, when an abscess develops between the coils of intestine, or between the mesentery and the omentum, or between the layers of the mesentery—it may have a well-marked excursion. E. LAPLACE (*Jour. Amer. Med. Assoc.*, 1901, vol. 2, p. 949) describes a case in which a distinct tumor the size and shape of the kidney was movable within an area having a radius of 3 inches about the umbilicus. This mass, which was made up of omentum, ileum, colon, and mesentery, was not adherent to the surrounding peritoneum. In its midst was a foul abscess and the gangrenous perforated appendix. A small abscess situated behind the cæcum or ascending colon may be very difficult and often impossible to detect, although its presence is strongly indicated by a long-continued remitting temperature. Percussion may reveal the presence of a tumor when on account of tenderness and rigidity palpation is unsatisfactory. The presence of a mass usually produces impairment of the normal tympany, and if placed

superficially there is absolute dulness over the most prominent portion, and relative dulness passing into the normal resonance as the margin is approached. Some impairment of the normal sounds may be found extending a considerable distance beyond the abscess itself, being produced by the presence of an abundant plastic exudate which mats together the omentum and the neighboring intestinal coils. The percussion note, however, is not an infallible guide, for, on the one hand, excessive rigidity of the abdominal muscles may be the cause of impaired resonance; and, on the other hand, a small retrocæcal abscess, or even one of considerable size, may be associated with a normal tympanitic note produced by the intervening dilated cæcum or small bowel. Again, with a deeply situated posterior abscess there may be normal resonance in the anterior abdomen and dulness in the posterior lumbar region. Sometimes percussion over a large, prominent mass may elicit a tympanitic note owing to the presence of gas in its interior.

Distention.—Slight meteorism at the outset is common in cases beginning with stormy symptoms, and may be due to constipation or to the formation of gas. When there is no inhibition of peristalsis, the distention only gives rise to discomfort, and as the affection becomes localized the abdomen usually assumes its natural appearance. With the beginning of spreading peritonitis the abdomen is often flat, and even scaphoid. Distention usually occurs early, however, and may be extreme, the abdomen being dome-shaped and perfectly motionless. In cases of distention due to profound infection, no sound whatever is heard on auscultation. RICHARDSON has observed that in cases of great distention there is also at times a serious interference with the portal circulation, the distended intestine being dark red or purple, and the portal radicles dark and prominent. In these cases the heavy distended coils can be felt through the abdominal wall. Portal thrombosis may give rise to a similar condition. Marked distention may also be occasionally observed in cases of profound toxæmia, without any evidence of mechanical obstruction or peritonitis. Extreme distention is one of the gravest symptoms observed in appendicitis, whether due to a local infection, to mechanical obstruction, or to general intoxication. It is one of the most significant signs of a general peritonitis. On the other hand, in severe, diffuse peritonitis the abdomen may be flat, hard and board-like; or it may be soft and natural looking in hopeless cases.

Vomiting.—This is a more or less constant and prominent early symptom of acute appendicitis. It may or may not be associated with nausea; less frequently, nausea occurs alone. There is often a single attack of vomiting at the beginning of the attack and it may not recur. More frequently it begins some hours after the onset of the pain and occurs only once or is repeated two or three times. It rarely continues for more than a few hours. In about 15 per cent. of the cases admitted to the Johns Hopkins Hospital there was neither nausea nor vomiting at any time during the attack. In several instances vomiting was directly due to the administration of medicine, and again, in other cases, it occurred only

after taking food. In a few instances vomiting continued at frequent intervals for one or two days, but in favorable cases it was never continuous. If the other symptoms subside, vomiting soon ceases, but with the onset of spreading or generalized peritonitis it may become persistent and uncontrollable. At first the contents of the stomach are ejected, and then bile-stained material. In unfavorable cases the material vomited may consist of dark greenish-black or brown material, but it is sometimes distinctly stercoraceous. The persistence of nausea and vomiting is always of grave significance, and an easy continuous regurgitation especially is, according to RICHARDSON, a more unfavorable symptom than occasional violent retching. *Hiccough* is comparatively rare, but it is occasionally observed in generalized peritonitis or when a large abscess extends upward and involves the diaphragm. It is usually an indication of the involvement of the peritoneal surface of the diaphragm, and is sometimes a prominent and distressing symptom.

Constipation.—Constipation is present in the majority of cases of appendicitis. As before noted, it is one of the most constant events preceding the onset of the attack, and it usually persists until the acute symptoms are over. When the bowels have previously been normal, or even when there has been a tendency to diarrhoea, constipation usually occurs with the appearance of acute symptoms. In a considerable number of cases the initial violent intestinal contractions cause a sudden evacuation of the bowels, and in a small number more or less severe diarrhoea may continue for a day or two, being then followed by constipation; in other instances diarrhoea persists throughout the entire attack. It is exceptional to find the bowels normal during the course of the whole illness. Constipation is often very obstinate, and there may even be complete obstruction. As a rule, the bowels are moved after the first few days, but continue more or less constipated until the end of the attack. This symptom, unfortunately, is often aggravated by the large doses of opium so frequently required for the relief of the first acute symptoms. Symptoms of complete obstruction may be due to intestinal paralysis caused by the direct invasion of the intestinal walls by the infective microbes or their toxic products; or there may be true obstruction due to kinks or strangulation produced by the inflammatory exudate. The characteristic picture of *ileus* then develops: constant vomiting, becoming stercoraceous, and absolute constipation without the passage of either faeces or gas. The abdomen usually becomes distended and acutely tender. With mechanical obstruction peristalsis is often at first plainly visible, but all intestinal movements cease when symptoms of peritonitis develop, whether the obstruction is due to adhesions or to primary intestinal paresis.

Hemorrhage.—*Hæmatemesis* has been described by TREVES, DIEULAFOY, MATHESON, and others, and is attributed generally to a toxic degeneration of the gastric mucous membrane with erosion of small blood-vessels. In the case reported by MATHESON (*Brit. Med. Jour.*, 1901, vol. 1, p. 1201) the hemorrhage was so severe that collapse and death occurred

within a few hours. Hemorrhage from the bowels is less rare, but not frequent. It was noticed in four cases out of almost a thousand admitted to the Johns Hopkins Hospital. In one of these cases there was a strong suspicion of tubercular disease; in the others no cause for the hemorrhage was discovered. In one instance the hemorrhage, which was preceded by diarrhoea, began four days before operation and continued until the fifth day after. It occurred at frequent intervals, and was always accompanied by severe griping pains in the abdomen. In another case blood, without any fecal matter, was passed *per rectum* for two or three days.

Jaundice.—This symptom occurs in a comparatively small number of cases of appendicitis, but it may possess considerable significance as an index to the patient's condition. On the other hand, it is sometimes a very misleading sign, because when associated with hypochondriac pain the appendical origin of the affection may not be recognized. Jaundice in appendicitis may be of the obstructive or non-obstructive type. The former is more common in cases of chronic inflammation, in which adhesions have surrounded the gall-bladder and its ducts. Non-obstructive jaundice is almost invariably present in cases of appendicitis accompanied with pyæmic abscesses of the liver, and is also found in cases with severe toxæmia. In the former, owing to the extensive disorganization of the liver, the jaundice is more intense than in the latter, and is also associated with other signs of the pyæmic process. The jaundice of toxæmia is usually slight, being often only noticeable in the sclera. It is always an unfavorable sign.

General Appearance.—The general condition of the patient often affords valuable information as to the progress of the disease. In cases of moderate severity there is at first an expression of suffering and occasionally an appearance of slight shock, but this soon passes off and the patient lies quietly, appears comfortable, and does not look very ill. The face is usually a little flushed and slight headache is common. In more severe infection the patient may look dull and heavy and answer questions slowly; later, there is often restlessness and slight delirium. At the outset in the milder forms the color is good, but with increasing intoxication the face appears dusky and the skin is bathed with cold sweat. The sclera are sometimes slightly icteric. General peritonitis is marked from the beginning by an expression of anxiety, but after recovery from the primary shock the patient for a time may appear to be improving, and look fairly comfortable and well. A sense of well-being is more or less characteristic of septic infection after the acute stage. When peritonitis is fully developed, the appearance is very characteristic; the expression is anxious, the face pinched, the nose sharp, the eyes sunken, the skin livid, or dusky and cyanosed, and the respirations rapid, shallow, and wholly costal.

COMPLICATIONS OF ACUTE APPENDICITIS.

Suppurative Peri-appendicitis.—On account of its frequency, its immediate danger, and its many troublesome sequelæ, abscess formation is the most important complication of appendicitis. Unhappily, notwithstanding

ing the constant effort of modern surgeons to forestall this event, it is still present in a large proportion of the cases admitted for hospital treatment, occurring in about two-thirds of the acute cases and in nearly one-half of all. Another fact, difficult of explanation, unless it be attributable to the still too great conservatism of the family physician, is that the percentage of abscess cases admitted to the Johns Hopkins Hospital during the past three years was practically the same as during the preceding ten. The individual symptoms of suppurative peri-appendicitis have been separately discussed in connection with the symptoms of acute appendicitis, and it only remains to give a general clinical picture of this condition. The onset of an attack of appendicitis which goes on to suppuration differs in no way from an ordinary attack. It may be ushered in with violent symptoms or it may have a gradual and sometimes very obscure evolution. In some instances suppuration is present from the outset, in which case the initial symptoms, often unusually severe, instead of showing the usual decline at the end of thirty-six or forty-eight hours continue unabated for a longer time. The abdomen at first is more or less distended and rigid, so that local signs of suppuration are hidden, but usually in a few days, although the general symptoms continue severe, meteorism and rigidity diminish and a mass may be more or less easily palpated. Sometimes, while it is impossible by palpation or percussion to detect any evidence of a mass, the persistence of an area of exquisite tenderness and the continued inclination to flex the right thigh point to a hidden focus of suppuration. In other instances suppuration develops later. The early acute attack is followed by a general amelioration of all the symptoms and the apparent improvement of the patient when, in a few days, a recrudescence of the fever is noticed, occasionally accompanied with a chill. The temperature keeps high, or assumes the characteristic remittent type of septic absorption. At the same time there is renewed soreness and sometimes acute pain in the right side, while a swelling develops more or less rapidly. In other cases, again, the initial symptoms are very misleading, being often not more than a slight soreness in the abdomen and a feeling of general malaise, the patient in the meantime going about as usual. TREVES refers to a case described by ROUX, where a man, aged forty-two, complained of some pain in the right iliac fossa, but continued his work as a carpenter for a week, the bowels acting regularly during this time. On the eighth day the pain became worse and the patient took to his bed, and on the ninth day a large perityphlitic abscess was evacuated. A similar case occurred in the practice of my associate, H. W. BUCKLER, as follows:

A boy, ten years old, suffered with frequent attacks of nausea, vomiting, and abdominal pain, relieved by purging and dieting. One day, after a heavy dinner, he complained of nausea, and later on he vomited his dinner. There was considerable colicky pain in the abdomen, but it was localized, and the next day he was much better and the pain was relieved. On the second day he had a dose of calomel, which caused ten to fifteen small stools, and he complained of much pain in defecation and also in micturition. When seen on the third day his temperature was 100.5° F. and his pulse 90; there was no pain nor

tenderness in the abdomen whatever, his only complaint being of difficulty and pain in micturition and pain on defecation. On rectal examination, a large soft mass, exquisitely tender, was found filling up the pelvis. During the following night there was rapid distention of the abdomen and the temperature rose to 102.7° F. and the pulse to 110. Operation early the next morning revealed a general peritonitis, and a large pelvic abscess containing over six ounces of pus. The appendix, which measured nine and a half inches in length, and was situated in the pelvis, was completely gangrenous and perforated at the base.

After the acute process has subsided, resolution and speedy convalescence may follow, or the abscess may remain more or less quiescent. It may be present for a long time with little constitutional effect, but, as a rule, there are the usual manifestations of chronic sepsis, namely, emaciation, progressive loss of strength, poor appetite, furred tongue, and ultimately, complete exhaustion.

General Peritonitis.—This condition is the most critical accompaniment of the early stages of acute appendicitis, and, although less frequent, is by no means a rare accident in the last stages. In some cases, symptoms of general peritonitis are present from the onset of the attack. In other instances (the more usual course) the affection first becomes localized in the right iliac region, and symptoms of the diffuse abdominal infection develop later. Out of about 50 cases observed at the Johns Hopkins Hospital, 3 showed symptoms of peritonitis from the beginning, 20 within the first forty-eight hours, and the remainder in from two to five days. Three cases gave a history of from nine to fourteen days' illness, but the exact date when the symptoms of peritonitis appeared was doubtful. Whether arising early or late, the onset of general peritonitic symptoms is usually very abrupt, beginning with intense radiating abdominal pain, nausea and vomiting, with a distinct chill, sometimes amounting to a severe rigor, and in a large number of cases followed by high fever. The pulse is rapid and full, the expression anxious, the face flushed, and the respirations hurried and shallow. There may be more or less profound shock, but, as a rule, the patient soon rallies. The abdomen at this stage is often flat, retracted, and board-like in its rigidity; there is general tenderness, marked cutaneous hyperæsthesia, and active muscle spasm. The respiratory movements are restricted or absent. The patient lies in the dorsal decubitus, usually with both knees drawn up. As the peritonitis becomes established, the constitutional symptoms become rapidly more pronounced, the patient looks feverish and shows more or less hebetude, the tongue is dry and coated, nausea and vomiting are almost continuous, there is complete obstipation, and the respirations are very rapid and altogether costal. The abdomen is now distended and motionless, its distention being sometimes especially marked in the epigastrium. The iliac and costal grooves may be completely obliterated and the area of liver dulness greatly reduced; there may be movable dulness in either flank, and the abdomen is everywhere exquisitely tender. When the peritonitis is fully established, the patient is seen to be very ill at the first glance; he looks septic and is often very restless; the facial expression is often dull and stupid or there may be a marked *facies hippocratica*; the

pulse is very rapid and irregular and the fever may be very high. In one case in the Johns Hopkins Hospital the temperature registered 109.2° F. shortly before death. Vomiting is usually continuous and is often stercoraceous. In other cases the patient is found in collapse, the skin pallid, cyanosed, and bathed in clammy sweat; the pulse irregular, rapid, and weak, the temperature low. Abdominal symptoms at this stage may be altogether lacking. In some cases, as the climax approaches, the subjective symptoms may be those of general well-being, and the patient is convinced he is improving. In the so-called fulminating forms of peritonitis, on the contrary, symptoms of collapse may be present almost from the first; the temperature may never rise above normal and it frequently becomes subnormal. Abdominal symptoms after the first acute onset may be inconspicuous. In such cases the overwhelming intoxication paralyzes the resistance of the organism from the onset, and rapidly advances to a fatal termination. TREVES mentions the case of a man, aged twenty-eight, who, after three weeks of "dyspepsia," during which time he was actively engaged in some outdoor work, was seized at two o'clock in the morning with definite symptoms of perityphlitis. When seen at 2 P. M. on the same day he was cold, pulseless, and dying. At 6 P. M. he was dead. Autopsy revealed perforative appendicitis. In favorable cases the severity of the symptoms gradually diminishes, the temperature falls, the pulse becomes stronger and slower, and ultimately convalescence is established.

Intestinal Obstruction.—The occurrence of intestinal obstruction in the course of acute appendicitis has already been described. But it may also occur as a late complication, and very commonly appears when the patient has fully recovered from all evidence of the affection; or, again, it may suddenly develop in the course of an unsuspected chronic appendicitis. It is due to the constricting bands and adhesions resulting from the former acute or chronic peritonitis, which produce a sharp angle or twist in the bowel or incarcerate a portion of intestine which has slipped under the band of adhesions. The symptoms are very characteristic: an abrupt onset with severe colicky pain, later becoming continuous and very intense; vomiting, which at first is the contents of the stomach, then bilious, and finally stercoraceous, and complete obstipation without the passage of flatus or fecal matter. The abdomen becomes distended, tympanitic, and acutely tender. The constitutional symptoms are severe and symptoms of collapse soon supervene. In the beginning the temperature is normal and may continue so. The axillary temperature may be subnormal. The pulse is rapid and weak; the tongue is dry and there is incessant thirst. Intestinal obstruction as a post-operative sequela is considered elsewhere (see Chap. XV).

Septicæmia.—The absorption of toxins from the primary focus of disease, in other words, toxæmia, is an accompaniment of the mildest as well as the most virulent forms of appendicitis, and is a part of the malady itself rather than a complication. There are, however, cases in which the microbes themselves enter the circulation, and toxins are then pro-

duced in the blood as well as absorbed from the primary seat of infection. In such cases the removal of the appendix is often attended with very disappointing results, as the general infection pursues its typical course uninfluenced by the removal of the primary seat of the disease. The symptoms of septicæmia may set in within twenty-four hours or they may not appear until the third or fourth day. There is usually a chill which may recur at irregular intervals. The temperature rises gradually and remains high, or is marked by daily remissions or intermissions; the pulse is rapid and small, and there is usually great prostration. The skin becomes pale or slightly icteric, the tongue is dry and covered with a dark brown coat. There may be marked mental disquietude and restlessness or the patient may gradually sink into a typhoid state and die in a comatose condition.

Pyæmia complicating appendicitis is characterized by the formation of abscesses in various regions, due to the transportation of septic emboli from the diseased area. The clinical picture of the most important of these metastatic abscesses, that is, abscesses of the liver, will be described later in connection with suppurative pylephlebitis. Less common areas of distribution are the spleen, kidneys, and lungs. Cases have also been reported of abscesses developing in the brain and in the parotid gland. The onset of pyæmia is marked by a severe chill, or rigors, with high temperature followed by profuse sweats. The chills may be repeated daily, or at irregular intervals. The fever may be slight in the intervals and there may be periods of apyrexia. There is anorexia, often with nausea and vomiting, and looseness of the bowels, the patient usually becoming greatly emaciated. The physical signs of abscess formation are readily detected in the lungs and in superficial regions, as in the parotid gland; in other cases they may escape observation. The disease may run a chronic course lasting for months, the condition of the patient varying from time to time, but the termination is usually fatal.

Pylephlebitis, Liver Abscess, Subphrenic Abscess.—Of the remote complications of appendicitis, pylephlebitis and its accompaniment, liver abscess, is the most to be dreaded. It is usually a late phenomenon, sometimes not appearing until several weeks after the subsidence of the appendical affection, and seldom developing before the end of the first week of the attack. It may follow the most severe form of appendicitis, but is commonly found associated with the less severe, subacute cases, and often with those of insidious development, the masked cases of TREVES. There are numerous recorded examples in which the patient, who previously had complained merely of indigestion or had been a little out of sorts, suddenly presented symptoms of the acute liver affection, the appendical origin of which was not suspected. The chief points in the clinical history are: severe pain in the right hypochondrium or epigastric region, and repeated rigors, followed by high fever and profuse sweats. Icterus is present in the majority of cases and is sometimes pronounced; the liver becomes enlarged and painful and there is rapid emaciation with progressive weakness. Subphrenic abscess

may give rise to a clinical picture resembling abscess of the liver. It is, however, usually associated with evidences of progressive purulent peritonitis. In addition to the general appearance of sepsis, hepatic tenderness and swelling are sometimes conspicuous features, but rigors and jaundice are not always so marked. The liver is sometimes secondarily affected, in which case the symptoms are the same as those described in connection with primary abscess of the liver. **Peripheral thrombosis and embolism** are occasional complications of appendicitis, but as they occur more frequently as post-operative events, they are described under that head in Chapter XX.

Lung and Pleural Affections.—The most frequent thoracic complication of appendicitis is **pleuritis**. WOLBRECHT (*loc. cit.*) found evidence of pleural involvement in 38 per cent. of the cases in GERHARDT's clinic, but this is undoubtedly much too high an estimate of its general frequency. There may be a simple sero-fibrinous pleurisy or an empyema. The latter is commonly a sequel of subphrenic abscess. Owing to the presence of the abdominal affection the pleural symptoms may be obscure, but they are frequently unmistakable, consisting of a sudden accession of fever, often preceded by a chill, severe lancinating pain in the side, dyspnoea, and slight cough.

Vesical and Renal Complications.—These are comparatively frequent events in the course of acute appendicitis. They may be of reflex nervous origin, or they may be of an inflammatory nature, a **pericystitis** or **cystitis** resulting from the implication of the bladder wall in the inflammation of the appendix. The reflex phenomena, as a rule, are symptoms occurring at the onset of the attacks, and are more or less evanescent. They are not in themselves of serious import and soon give place to normal function. The most common early manifestations are acute retention and painful micturition. Complete retention of urine may persist from twenty-four to forty-eight hours. In one of the cases admitted to the Johns Hopkins Hospital the attack of appendicitis began with acute, colicky, abdominal pain associated with pain in the bladder and complete retention for twenty-four hours. This was relieved by catheterization, and there was no further trouble. REYNES (*XIII Cong. intern. de méd.*, Paris, 1901) describes a case in which a typical attack of acute appendicitis was accompanied by retention of urine lasting for forty-eight hours. In a case described by BALZER the retention, which lasted for forty-eight hours, did not take place until the fifth day of the attack. These purely reflex phenomena do not necessarily indicate that the appendix occupies the pelvic position. In the majority of instances the bladder symptoms are not noticed until the second or third day of the attack, and are produced by the extension of the inflammatory reaction to the peritoneal covering of the bladder or to the infection of the deeper layers. As a rule, in these cases the appendix occupies the pelvic portion and is in direct contact with the surface of the bladder. In other cases the bladder infection is due to the extension of a suppurative peri-appendicitis into the

pelvis. The symptoms most commonly noticed are increased frequency and pain in micturition, tenesmus, and, less frequently, retention of urine.

The vesical irritability accompanying a simple pericystitis secondary to acute appendicitis usually diminishes with the subsidence of the active process and the definite limitation of the appendical disease. When, however, adhesions form between the appendix and bladder, dysuria may be the most persistent and most prominent symptom. A good example furnished me by W. W. KEEN is as follows: The patient, a medical student, aged twenty, gave a history of frequent attacks of pain in the right lower abdomen which began in the region of the appendix and extended downward and inward, causing considerable pain in the bladder and in the end of the penis. This was so marked a feature of the attack that a skiagraph was made in order to exclude the possibility of a urethral calculus. At operation the appendix was found hanging over the brim of the pelvis and attached to something soft in front of it, presumably the bladder.

A true cystitis is a comparatively infrequent complication of appendicitis, but it is one which may have the most serious consequences. An intractable cystitis may continue or there may be a persistent fistula, or, finally, a fatal termination may be the direct consequence of these conditions. All grades of the infection occur, from a mild diffuse inflammation to a purulent infiltration of the bladder wall, with more or less extensive necrosis and perforation. The classical symptoms of acute cystitis are present—namely, painful and frequent micturition, tenesmus, and pyuria or hæmaturia. The involvement of the ureter or of the pelvis of the kidney in the suppurative process may produce similar symptoms. Cases have been described in which the inflammatory exudate had caused complete stricture of the ureter with a consequent development of symptoms of acute pyonephrosis. I once operated upon a woman for myoma of the uterus, and found, at the same time, an inflamed appendix densely adherent over the right ureter, which was compressed by it and completely strictured. There was also a pyonephrosis, for which nephrectomy was performed later on. DIEULAFOY (*Presse méd.*, 1898, vol. 2, p. 281), in discussing the toxicity of acute appendicitis, has directed attention to the abnormalities in the composition of urine resulting from the absorption of toxic substances. The time at which these changes are observed varies according to the stage of the disease and its severity. The most important are the presence of albumen and of increased indican and urobilin, but, as the infection progresses, all the symptoms characteristic of acute toxic nephritis develop, namely, diminished secretion of urine, the presence of casts, desquamated epithelium, leucocytes, and hæmaturia of renal origin or hæmoglobinuria. Albumen is present, as a rule, in all acute febrile disorders, but, as pointed out by BAYET (*Thèse de Paris*, 1901), as appendicitis is at first a local affection, albumen may not be found in it at the outset. Later on, however, as the toxins become diffused it may be present in abundance. On the other hand,

owing to the acute gastro-intestinal disturbances at the outset, a great increase in the amount of indican may be noticed in the first few days.

Fatal Hemorrhage.—In a few instances the erosion of a large blood-vessel occurring during the course of an appendicitis or as a post-operative complication has led to a fatal termination. OSLER (*Montreal Hosp. Gaz.*, 1880) mentions an instance of fatal hemorrhage into the intestine, MATHESON (*loc. cit.*) a fatal hæmatemesis. The symptoms are those commonly produced by internal hemorrhage, and, as a rule, positive evidence is found in the passage of blood by the mouth or the rectum.

SYMPTOMS AND COMPLICATIONS OF CHRONIC APPENDICITIS.

Chronic appendicitis may follow an acute attack or the symptoms may be chronic from the beginning. There are three fairly distinct clinical forms of the affection, although they are not always sharply differentiated from one another: 1, the recurrent form, which is characterized by the occurrence of repeated subacute or acute attacks with intervals of perfect freedom from any clinical evidence of the disease; 2, the chronic relapsing form, in which the patient is never well and is subject to more or less acute exacerbations; and 3, the residual conditions, which denote the disturbances traceable to the influence of the adhesions, kinks, etc., resulting from preceding acute or chronic inflammatory attacks. The pathological conditions underlying any of these forms may be the source of the so-called latent appendicitis or *appendicitis larvata*, in which the infective process is in a quiescent state, but liable at any moment to burst forth into activity, and often terminating in acute perforative or gangrenous appendicitis. The clinical picture of chronic appendicitis is very varied, including in its mimicry almost all the chronic diseases to which the abdomen is subject. The chief symptoms are referred to disturbances of the digestive functions, but pain and tenderness may be troublesome and serious, and in consequence of the poor nutrition and the more or less constant suffering, there may be emaciation, great weakness and lack of energy, and often pronounced nervous manifestations.

The more severe recurrent and relapsing attacks are similar to the acute appendicitis already described. Constipation is one of the most constant symptoms of chronic appendicitis, and is often most obstinate. With it there are frequently more or less marked dyspeptic symptoms, especially after indulging in certain articles of food. Flatulency is especially common and sometimes seems to affect chiefly the ileocaecal region. It is probably due to a condition of stasis, owing to the presence of adhesions which inhibit to some extent the normal muscular contractions (CZERNY). Loss of appetite, furred tongue, and nausea are frequent accompaniments of the disturbed digestion. Diarrhoea is less frequent than constipation, but is a prominent symptom in a considerable number of cases. It is, perhaps, most common in the more severe forms, in which the patient is in a state of chronic sepsis. The

diarrhoea may be persistent or may alternate with periods of constipation.

Pain and tenderness are characteristic symptoms in the majority of cases. The pain, as a rule, is definitely localized in the right abdomen, but, as in the acute affection, there is scarcely a spot in the whole abdomen to which it may not be referred. It is not often acute, being generally described as a dull ache, or merely a vague sense of discomfort. Occasionally, during the height of digestion, more or less severe colicky pains may be complained of, or, again, the pain may be noticed only during active exercise. I know of two cases in which the pain, which was very severe, was always referred to the rectum, and at operation the appendix was found lodged in the pelvis and adherent by its tip to the rectum. In women dysmenorrhoea is often a prominent symptom of chronic appendicitis, and in every case where dysmenorrhoea follows an attack of acute appendicitis, the presence of the chronic form of the disease should be suspected.

The association of membranous colitis and chronic appendicitis is frequently observed. FINNEY has especially noted its occurrence in cases where there is a thickened, chronically inflamed appendix, densely adherent to neighboring intestines. Some writers have attributed the disease of the appendix to the influence of the chronic colitis, but the evidence as a whole is in favor of the appendical origin of the trouble, the affection of the colon being secondary. In many instances acute attacks of appendicitis have antedated the appearance of symptoms of colitis, and it is a common experience to find that the latter is entirely relieved by the removal of the appendix. LAPEYRE (*Zeit. f. Chir.*, 1903, p. 498) described six cases in which coincident appendicitis and muco-membranous colitis were cured by the removal of the appendix.

INTERMITTENT DYSENTERY.—In this connection, T. S. CULLEN says: "I have seen a number of cases where the patient complained of intermittent dysentery. Many of them gave a history of intestinal obstruction, pointing strongly to a chronic appendicitis, and then later on developed periodic attacks of dysentery. In several of these cases I have removed the appendix and the dysentery has permanently ceased. It seemed as if the appendix kept up the irritation, and that as soon as this was relieved, the trouble in the colon disappeared. In other cases the dysentery has persisted for some time after the removal of the appendix."

CHAPTER XI.

DIAGNOSIS. DIFFERENTIAL DIAGNOSIS.

Diagnosis.—It is generally recognized that appendicitis is by far the most common inflammatory disease of the abdomen, especially in men under thirty and in children of both sexes. Sudden pain in the right iliac fossa with local tenderness and muscular rigidity are significant of the disease in the large majority of instances; there are, however, many cases of obscure development in which the cardinal signs of appendicitis are very inconspicuous; moreover, as pointed out by MYNTER (*Appendicitis*, 1898), few diseases present so many stages each characterized by a different set of symptoms, while, on the other hand, every one of these cardinal symptoms may be absent, or, if present, may indicate some other affection. The physician may not see the patient—in fact, he rarely does see him—during the initial stage of the attack, and by the time the disease comes under observation, the acute symptoms have subsided and the pain has become localized—it may be in the right iliac fossa, but frequently at a point remote from the normal position of the appendix; again, in other instances, the pain may have ceased entirely, and there may be a lull in all the symptoms, which in one case denotes improvement and in another marks the onset of grave complications. It is not only the combination of symptoms and their appearance in a distinct order, however, which indicate the character and progress of the malady, but the impression made upon the trained mind by their combination and progress. In every case, therefore, a clear description of the onset and course of the attack should be obtained, the subjective and objective symptoms carefully weighed, and, what is often of the utmost importance, the history of the patient in regard to previous attacks of appendicitis investigated. Finally, when the diagnosis has been made in this manner by direct evidence, it should be confirmed by a general examination of the patient, in order to verify it by exclusion and thus avoid the chagrin of operating for a supposed appendicitis and finding a case of, perhaps, thoracic disease with pronounced abdominal manifestations. The recognition of appendicitis in the majority of cases is easy, but it is often difficult and sometimes impossible to determine the grade of the infection and the extent of the complications; moreover, in the early stages of the disease there are no symptoms nor combination of symptoms by which the probable course of events can be foretold with any certainty.

In the presence of the cardinal symptoms, namely, sudden, acute abdominal pain, tenderness on pressure

over or near McBurney's point, and localized muscular rigidity, the diagnosis of appendicitis is justified in the majority of cases. Confirmatory symptoms, such as nausea and vomiting, constipation or diarrhoea, elevation of temperature and acceleration of pulse, make the diagnosis more secure, and the presence of the tumor puts it beyond doubt.

It must be remembered, however, that the position of the appendix is very variable, and it may be situated at almost any point in the abdomen, hence the local symptoms are sometimes referred to the region of the gall-bladder, to the left side of the abdomen, to the hypogastric region, or to the pelvis. Transposition of the viscera must be borne in mind. H. L. NIETERT (*Interstate Med. Jour.*, March, 1903) records a case in which there was an entire absence of local symptoms referable to the right iliac region, but there was dulness in the left iliac fossa. A median incision showed a transposition of the viscera and a gangrenous appendix on the left side. HAROLD HEPPLETHWAITE (*Brit. Med. Jour.*, 1907, vol. 2, p. 1579) had a case of a boy of sixteen with complete transposition of all the viscera. The boy developed an abscess in the left iliac region, and at operation by Mr. Moynihan the gangrenous appendix was found in the abscess. In a case referred to by FOWLER, operative interference was delayed on account of the absence of symptoms referable to the right iliac fossa, although the clinical picture suggested an acute perforative appendicitis. At the autopsy the appendix was found lying to the left of the median line, about an inch above the level of the umbilicus and fixed in this position by a short mesocolon. Hypogastric pain with tenderness and rigidity on both sides is very characteristic of pelvic appendicitis.

During the early stages of the disease—a period when operative interference could save almost every case—it is unfortunately impossible to determine whether there is a simple inflammation which will undergo speedy resolution without surgical treatment, or if the case will proceed to the most dangerous extremities, gangrene or suppuration being already, perhaps, at hand. In general it may be said that if the attack begins with slight or moderate local symptoms and mild constitutional disturbance, it is probably an ordinary catarrhal or a diffuse inflammation, and if the symptoms do not increase in severity, but show a general improvement at the end of twenty-four to thirty-six hours, recovery will take place without further complications. A sudden onset with violent pain, high temperature and rapid pulse, on the other hand, usually indicate a more immediately dangerous condition and in some cases there is reason to believe that the first acute symptoms are due to beginning peritonitis, the result of perforation, gangrene, or a virulent infection. Intense agonizing pain at the onset is often due to a perforation. Collapse symptoms, whether appearing in the beginning or later in the attack, if the patient does not quickly rally, are significant of a virulent infection with general intoxication. As a rule, the patient is not seen during the earliest stages

of the disease, several hours or even a day elapsing before a physician is summoned; much importance therefore attaches at this time to the following questions: Are the symptoms, both general and local, subsiding; are they becoming more severe; or are they apparently stationary? If after twenty-four hours the patient is seen to be getting worse instead of better, complications may usually be expected. If after thirty-six to forty-eight hours there is continuous high fever and a correspondingly rapid pulse, suppuration or a general infection is strongly suggested. A rapidly increasing pulse-rate, especially when out of proportion to the degree of fever, is one of the most urgent symptoms, usually signifying gangrene, or perforation with beginning peritoneal infection, or a general septicæmia. A sudden accession of local pain usually indicates a dangerous change due to the beginning of perforative peritonitis, and if the pain again becomes diffuse, especially if it is associated with shock, there is probably a sudden effusion into the general peritoneal cavity. A lull in the local symptoms, particularly in the presence of an increasing pulse-rate, is often due to gangrene or perforation of a pyo-appendix, and is soon followed by more or less quickly developing peritonitic symptoms, unless, indeed, the patient succumbs to a rapidly fatal toxæmia.

SUPPURATIVE PERI-APPENDICITIS.—This condition is recognized by the continuance or the recrudescence of high fever and rapid pulse after the second or third day, associated with pronounced local symptoms and the absence of any evidence of general peritonitis. The most positive proof of a circumscribed abscess is the presence of a tumor. It must be remembered, however, that a mass may be due to a plastic exudate, gluing together contiguous structures, or to the adherent rolled-up omentum, or it may even be simulated by rigidity of the abdominal muscles. On the other hand, a small focus of suppuration may exist without giving rise to a palpable tumor. At a later stage, when the abscess is firmly encapsulated, constitutional disturbances diminish owing to the lessened absorption, and the pulse and temperature may become normal. Fluctuation is usually not detected in the beginning of the attack, and often not at all. In the case of a pelvic abscess, however, as in one instance in my own practice, a fluctuating tumor may sometimes be detected on the second day. In the absence of distinct local signs, continuous fever may depend upon some remote metastatic infection such as pyelephlebitis or liver abscess. But these complications usually occur later in the course of the disease, and, as a rule, are attended with unmistakable symptoms.

PROGRESSIVE PERITONITIS.—The onset of spreading peritonitis is indicated when the local pain, tenderness, and rigidity again become generalized and the pulse-rate increases. Confirmatory signs, such as chills, persistent nausea and vomiting, elevation of temperature, especially in the rectum, and an anxious expression, usually appear early, but much valuable time will be wasted, and the present deplorable failure of operative interference in this class of cases will continue, if such pronounced

symptoms are waited for, because when the classical signs of a fully established peritonitis are present, the case is practically hopeless. Peritonitis occurs most commonly between the second and fifth days, an interval which is the danger period of appendicitis. It must be remembered, however, that the first symptoms of the attack may be those of a beginning peritonitis.

OBSCURE AND MASKED FORMS OF APPENDICITIS.—There are certain cases of appendicitis which are not attended with any of the usual clinical manifestations, and the patient may pursue his usual avocation until sudden evidences of some remote sequela develop, the appendical origin of which is not suspected. A striking example is related by TREVES, in which a middle-aged gentleman, after being a little out of sorts, was seized with pain in the hepatic region attended by a rigor and a subsequent rise of temperature. The rigors were repeated, the fever became very high, jaundice supervened, and it became evident that the patient was suffering from pyelphlebitis and liver abscess. No mischief could be detected, however, in any part of the abdomen except about the liver. In fourteen days he died, when the liver was found riddled with abscesses; the appendix, which was disorganized and filled with pus, had evidently been the seat of long-standing disease. J. C. MUNRO (*Therap. Gaz.*, Jan. 15, 1901), in a paper with the title "Lymphatic and Portal Infection following Appendicitis," calls attention to the frequency with which the retroperitoneal lymphatics are infected in appendicitis. It often happens that the original appendicitis is of little moment, and in many instances the appendix has been removed, and convalescence is progressing favorably, when the temperature goes up, there is spasm and tenderness, with, later on, fulness in the right loin. A secondary operation and incision in the loin give exit to pus from suppurating retroperitoneal glands. MUNRO cites one instructive case of a girl of seventeen who entered his service in the Boston City Hospital with a history of sudden sharp pain in the umbilical region coming on ten days before, with vomiting. Four days before entrance there was dull continuous pain in the hepatic region, followed by chills, and a leucocytosis of 9000. A tumor without tenderness could be felt below the costal margin on the right side of the abdomen. Tenderness and spasm over the loin developed. Local tenderness on deep pressure over the appendix was also present. The diagnosis was in doubt. At operation several groups of small abscesses were found on the upper surface of the right lobe of the liver. A second incision over the appendix revealed a foul abscess cavity. Both wounds were drained. On the third day the appendix wound was clean and sweet, but the liver wound discharged foul pus. Death on the fifth day.

In other cases the clinical phenomena are vague and misleading, the symptoms never being referred to the right iliac region and not being acute. There is a feeling of general malaise, with loss of appetite, furred tongue, constipation or loose bowels, and a little swelling and tenderness of the abdomen. The patient may be able to walk and even to work while an

appendicitis is progressing and a large abscess developing. FITZ (*Amer. Jour. Med. Sci.*, 1886, vol. 92, p. 331) mentions the case of a sailor who was at work rolling barrels of flour until the day of his admission to the hospital. He had then a prominent fluctuant tumor extending along the outer half of Poupart's ligament. The gradual evolution of the malady with slight pain, swollen and slightly tender abdomen, and the absence of localized symptoms may strongly suggest tubercular peritonitis. N. A. POWELL of Toronto (*personal communication*) operated upon a man who had been ill for three years, being about one-half of the time confined to bed, with supposed tubercular peritonitis. After removal of the inflamed appendix his health was completely re-established. Similar cases are mentioned by BROCA (*Thèse de Lyon*, 1901). In other cases, again, the patient suddenly develops collapse symptoms, or general septicaemia appears without any pronounced abdominal symptoms. A history of preceding attacks of appendicitis is an important aid in the diagnosis of these obscure cases. It must also be borne in mind that many obscure cases of liver abscess, abscess of the lung or pleura, and cases of cryptogenetic septicaemia are of appendical origin.

EXAMINATION OF THE PATIENT.—The characteristic posture of the patient in appendicitis immediately arrests the attention. Almost without exception he assumes the dorsal decubitus with the right leg slightly flexed, and exhibits an evident desire to avoid all movement. I once saw the case of a young girl where the only prominent symptom was the characteristic attitude. There was no spontaneous pain, and firm pressure over the region of the appendix did not elicit any tenderness or perceptible spasm. The temperature was 99° F., the pulse 80. There was, however, a history of acute abdominal pain on the preceding day, and when I saw her she was lying on her back with the right knee drawn up, plainly avoiding all movement whatever. In the afternoon of the same day the temperature was 99.8° F., and the pulse slightly accelerated. Operation, performed immediately, revealed a deeply situated appendix, which was swollen, turgid, almost mahogany colored, and covered with flakes of greenish lymph.

Abdominal examination must include inspection, palpation, percussion, and auscultation.

Inspection.—The abdomen in ordinary cases appears normal or it may be slightly distended. It is usually symmetrical, but there is sometimes slight fulness in the lower quadrant, possibly due to some distention of the cæcum, and the right iliac groove may not be so well marked as the left. A distinct prominence indicates an encapsulated abscess. The respiratory movements are usually free in all parts; limitation of the respiratory movements in the right lower abdomen is evidence of a localized peritonitis, and absence of all abdominal movements shows a general peritoneal infection.

Palpation.—Before palpating the abdomen, the head and thorax should be somewhat elevated, the knees and thighs slightly flexed, and

the patient made to relax thoroughly. He then must be put off his guard by questions, while at the same time the hand is passed over the entire abdomen, the right iliac region being avoided, and a little pressure made here and there to discover any points of tenderness, while at the same time a definite idea is obtained as to the general condition of the abdominal walls. The confidence of the patient being thus gained, the surgeon, still distracting his attention, makes a few rotary movements with slight pressure with the finger-tips over the right iliac fossa, noticing if there is any complaint of pain, and also, especially, any rigidity or spasm of the muscle; and then, without delay, before the patient has time to guard against the attack, he makes deep pressure with one or two fingers over McBurney's point down into the head of the cæcum, when, if there is any inflammatory trouble, the patient at once cries out and catches his hand. In doubtful cases of appendicitis the tactual sense may be supplemented and confirmed by the use of the instrument, *piezometer*, shown in Figs. 95 and 96. This may be used as an *algесimeter* to determine the amount of pressure necessary to elicit tenderness over the appendix, and may also be used to estimate the degree of rigidity in the right iliac fossa by comparing the rigidity of the right and left rectus muscles. For example, with a pressure of 500, the button on the end of the rod may indent the abdominal wall so that the wheel registers 1 cm. on the right side, while at a corresponding point on the left side it registers 1.5 cm. or more. In this way the rigidity is demonstrated beyond a question and no allowance need be made for difference in tactual sense. At the same time the graduated rod indicates the amount of pressure necessary to elicit pain. (*Johns Hopkins Hospital Bulletin*, Sept., 1904.)

In acute cases, and also in patients with thick abdominal walls, it is seldom possible to palpate the appendix. Moreover, the attempt to do so is not without danger, as the distended or gangrenous appendix may easily be ruptured. In chronic appendicitis the thickened, erect appendix is plainly felt. In order to detect the appendix according to the method described by Edebohls, the examiner seeks the margin of the right rectus muscle, on the line between the navel and the anterior superior spine of the ilium. Then with light steady pressure the fingers are introduced under the margin of the

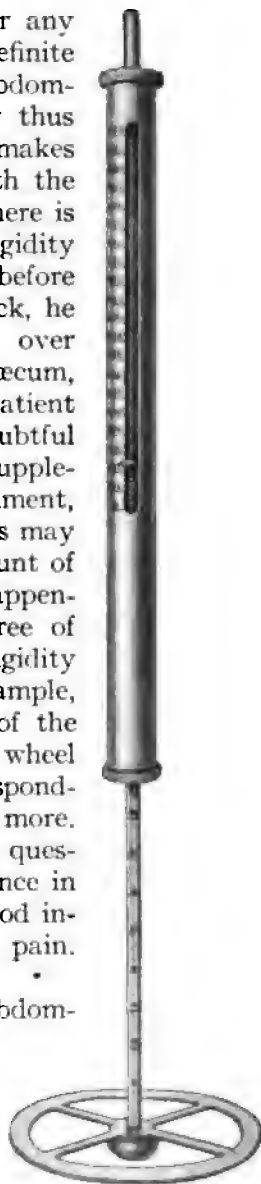


FIG. 95.—Piezometer used to measure the amount of pressure necessary to produce pain, as well as the force required to overcome the resistance of the muscular spasm as compared with the opposite side. The piezometer affords an objective method of demonstrating the presence of pain and resistance. The barrel contains a spring and both cylinder and rod are graduated. (One-half natural size.)

rectus until the common iliac artery is distinctly perceptible. The appendix, as a rule, is felt just outside the artery, its insertion being about an inch distant from the vessel while its tip often crosses it. A perityphlitic exudate may at first be masked by the rigidity of the abdominal



FIG. 96.—Showing the method of using the piezometer to determine the amount of pressure needed to produce pain. The sliding wheel indicates the depth of the depression produced by a given amount of pressure, and the muscle spasm is estimated when comparison is made with the corresponding point on the opposite side.

wall, but as the acute process subsides, it is usually easily recognized. Examination under ether will often reveal the swollen appendix or the presence of an exudate which could not otherwise be detected. This method, however, is seldom indicated except as a guide in making the

incision. The examiner must always bear in mind the risk of rupturing the appendix or an encapsulated abscess, an accident which has more than once occurred.

In some obscure cases a valuable aid in examining the patient, described by B. McMONAGLE (*personal communication*), is the pain elicited by holding the fingers firmly over the abnormal site of the appendix and requiring the patient to contract the right psoas muscle by flexing the lower limb, held rigid at the knee, on the body. A rectal examination, and, in married women, a vaginal examination as well, should never be omitted, as it serves not only to exclude affections of the pelvic organs, but is often valuable in locating the appendix and in revealing its diseased condition. In children, particularly, the inflamed appendix may be palpated *per rectum* even when not in the iliac fossa. In adults, however, this method of examination is chiefly of use when the appendix is situated in the pelvis, when on bimanual examination,—*i.e.*, with one hand on the abdomen and a finger of the other hand in the rectum,—it is sometimes possible to outline the swollen, inflamed appendix or a peri-appendical exudate.

R. J. MORRIS (*Jour. Amer. Med. Assoc.*, Jan. 25, 1908) has called attention to hyperæsthesia of the right lumbar ganglia in determining the presence of an acute actinomycotic inflammation of the appendix. He says: "Draw a line from the right anterior superior spine of the ilium to the navel; on this line, at a point one and a half inches from the navel, pressure will produce sensitiveness if the right lumbar ganglia are inflamed. In the early stages of an acute infective process of the appendix the right lumbar ganglia are tender and the left lumbar, lying at a similar point on the left, are not so. In acute cases McBurney's point, lying at the opposite end of the line, is of prime importance and the lumbar ganglia a point of secondary consequence. In chronic cases, on the other hand, tenderness at the point near the umbilicus is of considerable value from a diagnostic stand-point, because it may be present when tenderness over McBurney's point is absent." Dr. MORRIS has found lumbar ganglia tenderness of importance in differentiation between salpingitis and appendicitis. In the former condition both right and left Morris points are sensitive; in the latter only the right. In his experience any case of irritation of the lumbar ganglia originating in the pelvis causes tenderness of the ganglia on both sides, whereas irritating influences originating in the appendix cause tenderness of the right side alone.

Percussion.—Normal tympany should be present throughout the abdomen, with more or less modified resonance over the region of the appendix, in the presence of an omental tumor or a greatly distended appendix, or when there is an exudate. Absolute dulness, if present, is due to a very extensive fibrinous exudate or to an abscess; movable dulness in the flanks indicates the presence of effusion into the general peritoneal cavity.

Auscultation.—This is chiefly of use in determining whether symptoms of ileus are due to mechanical obstruction or to intestinal paralysis.

Urine.—The changes in the urine may be of some value in the diagnosis of a few obscure cases of appendicitis, especially in the differential diagnosis between appendicitis and pneumonia or typhoid fever. The early appearance of indicanuria and the relatively later appearance of albumen are the most distinctive features (see Chap. XIII).

Differential Diagnosis.—The frequent possibility of error in the diagnosis of appendicitis is shown by the large number of cases collected by J. M. SPILLISSY (*Ann. Surg.*, 1902, vol. 35, p. 758) illustrating the various lesions of the pelvis and abdomen which have been mistaken for appendicitis. The most important sources of error are in the acute visceral affections, most frequently in those which result in peritonitis. There are, as noted by TREVES, "certain symptoms common to all acute disorders within the abdomen at their outset, in which a sudden and violent impression is made upon the great nerve centres. These symptoms consist of intense and sudden pain in the abdomen, of collapse in varying degree, and of a certain amount of vomiting. At the very outset such conditions as perityphlitis, renal and gallstone colic, twisting of an ovarian pedicle, torsion of a movable kidney, general peritonitis, and intestinal obstruction, have been confused one with another." It is also well recognized that acute intrathoracic affections, particularly in children, may in the beginning be characterized by abdominal symptoms so sudden and violent that the disease itself is entirely masked.

GASTRO-INTESTINAL DISEASE.—The gastro-intestinal diseases liable to be confused with appendicitis are acute gastritis and gastro-enteritis. Appendicitis is frequently mistaken for acute indigestion, but simple digestive disturbances are seldom mistaken for appendicitis. Intestinal colic, when chiefly affecting the appendical region, in the beginning may simulate appendicitis, but is distinguished by the entire absence of objective signs. In the severer forms of gastritis the attack may set in with a chill, fever, and vomiting. There may be constipation, but very often there is diarrhoea. The abdomen may be swollen and slightly tender in the epigastric region. In the acute forms it may at first be impossible to make a definite diagnosis, but the absence of symptoms referable to the right iliac region and the general freedom from tenderness and rigidity are sufficient to put the examiner on his guard. Acute enteritis in children may set in very brusquely with vomiting, colicky pain, and high fever. The abdomen is sensitive and the child lies with its legs drawn up. The frequency of this affection in young children and the characteristic frequent, offensive stools should prevent error. Acute enteritis accompanied by extension of the inflammation to the peritoneal surface may present a very close resemblance to appendicitis. A case related by QUENU and CAVASSE (*Bull. et. mém. de la Soc. de chir. de Paris*, 1900, vol. 26, p. 821) is that of a boy, aged seventeen, who suffered from violent abdominal pain, constant vomiting, and obstinate

constipation. After two days his bowels were moved with enemata. The same evening there was slight abdominal distention, tenderness and rigidity in the right iliac fossa, slight fever, and a *hippocratic facies*. A diagnosis of appendicitis was made. Operation revealed a normal appendix, but the small intestines were congested and covered with a slight exudate, especially over the lower part of the ileum.

Stercoral typhlitis is now recognized as a rare affection. It is, however, occasionally confused with appendicitis. The diagnosis of the condition is fully described in Chap. XV.

Foreign bodies in the intestine, especially in the cæcal region, have frequently been mistaken for appendicitis. For example, in a case described by MUMFORD (*Bost. Med. and Surg. Jour.*, 1899, p. 602) a girl, aged twelve years, was suddenly seized with severe abdominal pain referred to the umbilicus, followed in a few hours by vomiting. Her bowels were moved with castor oil, but the pain increased, being especially severe in the right iliac region. On the third day the temperature was 103° F. and the pulse 112. Her abdomen was distended, rigid, and tender, especially over McBurney's point. Operation revealed a normal appendix and the cæcum distended with a mass of orange pulp. The differential diagnosis in such cases can only be made by an exploratory laparotomy.

Perforation of gastro-intestinal ulcers, as well as large perforations of the appendix in which there is an extensive extravasation of septic material, are all accompanied with sudden excruciating pain, followed almost immediately by symptoms of shock. In all of these conditions the initial pain is commonly referred to the umbilical or epigastric regions, and in the absence of a history pointing to gastric or intestinal ulcer, the differential diagnosis is often impossible without an exploratory operation. In perforative appendicitis, however, there is usually a predominance of tenderness and rigidity in the right iliac region, while if the pain and other symptoms continue to be localized in the epigastrium, perforated gastric ulcer is probable. The less acute forms of gastric ulcer, where adhesions have formed, or where perforation occurs into the lesser abdominal cavity, are not apt to be confused with appendicitis. A further aid in the differential diagnosis is the greater liability of young women to the acute forms of gastric ulcer. With a preceding history of gastric disturbance, especially of hæmatemesis or of hemorrhage from the bowel, the diagnosis of gastric or duodenal ulcer is seldom doubtful. The possibility of the coexistence of the two affections, as in the cases of TREVES and MATHESON, already cited, should be borne in mind. A definite diagnosis of intestinal perforations, especially when situated in the terminal portion of the ileum, the cæcum, or the ascending colon, can seldom be made without an exploratory incision. In a case described by DEEVER, where a diagnosis had been made of acute appendicitis with general peritonitis, there was a perforation of the ileum about 1½ or 2 in. from its junction with the cæcum. In QUINARD's case

(cited by Spillissy) the cæcum and appendix were normal, but there was a perforation in the ileum 30 cm. from the ileocæcal junction.

Ulceration and perforation of the intestine due to the specific inflammatory affections, more especially typhoid fever and tuberculosis, are somewhat frequently confounded with appendicitis; and, on the other hand, appendicitis has sometimes been mistaken for these conditions. The clinical features of these diseases are fully considered in Chaps. XIII and XXIII.

The relation of mucous colitis and appendicitis is interesting. As I have said elsewhere, obstipation and colitis with mucous stools are often the sign of a latent appendicitis, and are cured by the removal of the appendix. The differential diagnosis, as a rule, rests upon the history of mental strain or worry preceding the onset of the trouble and the presence of marked nervous manifestations, such as hysteria, hypochondriasis, etc. On the other hand, a history of a preceding acute or chronic appendicitis is exceedingly suggestive of the appendical source of the trouble. In any case of mucous colitis in which nervous symptoms are not a predominant feature of the disease, appendicitis should be suspected.

Tumors in the ileocæcal region or in the ascending colon may be mistaken for appendical disease, particularly when symptoms of perforative peritonitis occur in a person who had not previously suffered from any distinct evidence of the disease. The exudate accompanying appendicitis, on the other hand, has also frequently been mistaken for a true neoplasm. Intestinal tumors may progress without pain, unless the parietal peritoneum is involved, and in the absence of ulceration there may be but slight digestive and constitutional disturbances. As a rule, however, there is a history of attacks of pain, the passage of blood and mucus in the stools, loss of weight and of strength. In late cases these symptoms are aggravated and there may be more or less cachexia. Symptoms of chronic obstruction are frequently observed. There may be slight fever, and leucocytosis is usually present. A tumor can generally be detected. The differentiation between the tumor in the case of a new growth, and a peri-appendical exudate is often perplexing. As a rule, a new growth is more or less freely movable, is sharply circumscribed, and develops gradually; while a perityphlitic inflammatory mass is less movable, less definitely outlined, and develops rapidly, usually with acute local and constitutional symptoms. The new growth, however, may be adherent to contiguous structures and immovable; while, on the other hand, an inflammatory mass may possess considerable mobility. Again, the neoplasm may apparently develop suddenly in a person in good health, whereas the inflammatory exudate may be present for months or even years, as in FENGER's case, and may sometimes be accompanied by progressive emaciation and cachexia. Two years ago I operated upon the wife of a physician for what was supposed to be chronic appendicitis. She had been perfectly well, except for some trifling indiges-

tion, until about six weeks before operation, when she suffered from a moderately severe attack of pain in the right iliac region associated with some fever, accompanied, it was said, by a leucocytosis of 12,000. She was ill for about three weeks, and after the acute symptoms had subsided she occasionally felt some slight pain in the right side, while there was a small, definitely circumscribed mass in the iliac fossa, which was not freely movable, and was not very sensitive. There was no disturbance of digestion and the bowels were normal. Operation revealed a normal appendix and a carcinoma of the cæcum. The age of the patient is of some value as an aid to the diagnosis, but it must be remembered that new growths are not rare in youthful persons and that appendicitis sometimes occurs in advanced life.

LENZMANN states that the distention of the bowel with air is sometimes an aid in differential diagnosis. In the case of carcinoma, which, in the majority of cases, is an annular growth, the cæcum becomes contracted when the intestine is distended by gas, but an inflammatory exudate does not, as a rule, prevent its dilatation. This procedure, however, is not always trustworthy, as a new growth may be limited to the posterior surface, and would not then interfere with the cæcal distention, while, on the other hand, extensive adhesions in inflammatory cases may greatly limit it. A. GERSTER (*N. Y. Med. Jour.*, Aug., 1902) had a case of relapsing appendicitis in a man, twenty years old, which presented the following points of resemblance to a neoplasm of the ileocaecal region: A large rounded tumor of gradual development, movable, giving very little pain when the patient lay quietly in bed, and not accompanied by chills nor rise of temperature, the bowels being regular. The chief points in favor of the inflammatory nature of the tumor were the age of the patient, and especially the history of three previous attacks of appendicitis.

Ileocaecal tumors of tubercular origin are distinguished from malignant growths on the one hand, and simple inflammation on the other, by their slow evolution, their characteristic contour, and especially by the history of antecedent tubercular trouble, or the presence of enlarged, hard glands in the cervical or other region.

Acute intestinal obstruction may be due to strangulation, volvulus, intussusception, strictures, or foreign bodies. In all of these conditions the symptoms are similar to acute appendicitis, and all have been confused with it. If the case is seen early there is, in the majority of cases, no difficulty in the differential diagnosis, the acute onset with severe abdominal pain, becoming more intense and continuous and soon followed by vomiting of at first the contents of the stomach, then bile, and then fecal matter, being very characteristic. The presence of obstipation and early collapse are also most important diagnostic features. The absence of fever at the onset and of early high leucocytosis, as well as the absence of early abdominal tenderness, distinguish it from appendicitis. Later on, when symp-

toms of peritonitis develop, the differential diagnosis may be impossible unless a clear history of the onset of the attack can be obtained. Strangulation of the intestine by bands of adhesions, by a Meckel's diverticulum, by the adherent appendix, or by its incarceration in peritoneal pockets, is most commonly mistaken for appendicitis. SPILLISSY has collected 18 cases of obstruction due to trouble involving Meckel's diverticulum, in which a diagnosis of appendicitis was made. Diseases of this rudimentary structure cannot be distinguished from appendicitis before operation (see Chap. XVII).

Incarcerated internal hernia may readily be confused with appendicitis, particularly when the incarceration is not complete. As a rule, however, there are early signs of complete obstruction, while symptoms of ileus in appendicitis are not present in the beginning of general peritonitis, but follow its development. J. B. DEEVER observes that incipient hernia may simulate chronic appendicitis. Palpation of the inguinal rings will usually reveal the source of the trouble in such cases.

Intussusception may present a close resemblance to acute appendicitis. In both there may be the initial, severe, colicky pain, vomiting, and collapse. The pain may be confined to the right side and a tumor may be felt. In intussusception the pain resembles a severe colic and is often relieved by pressure; vomiting is more marked, and there is severe tenesmus with escape of blood, or of blood and mucus from the bowels. The tumor is better defined, less tender, and movable. In every case of acute colic in young children the question of intussusception should be considered and the examination directed to its possible discovery. Examples of this condition are given in Chap. XIV.

The question of carcinoma in the differential diagnosis is raised by the following case, the only one reported of intussusception in an adult. The operation was done with the expectation of finding a malignant affection, and even when the abdomen was opened, it was not possible at first to get a clear idea of the nature of the disease.

(HAESLER, *loc. cit.*) A woman, forty-two years old, who had always had good health, fell from an electric car, receiving a blow on the head, after which she was ill in bed for some time, suffering from sleeplessness and severe vomiting. One night she had a sudden severe pain near the navel, extending toward the right iliac fossa. No resistance was perceptible at first, but after three weeks she noticed a knot in her abdomen which was freely movable and increased in size. The attacks of pain continued at intervals for six weeks, when she entered the hospital. Examination then showed a smooth tumor in the right iliac fossa, the size of a large fist; her bowels moved only after medicine, and she was suffering from meteorism, nausea, and vomiting. Her general condition was so bad and she was so much emaciated that a provisional diagnosis was made of carcinoma of the ascending colon. On operation the cæcum and the vermiform appendix could not be found. After separating adhesions so thick as to resemble a solid tumor, the intestine was resected from 10 cm. above the ileum to the hepatic flexure of the colon. The patient recovered and was in good health three years after the operation. Examination of the resected portion of the intestine showed the ileum passing directly into the colon, the cæcum and the appendix being apparently lacking. On cutting into the bowel, the valve and the invaginated appendix could be seen projecting into its lumen. The appendix was the most prominent portion, so that it seemed not unlikely that it was the starting-point of the difficulty. Its lumen contained a small amount of fecal material.

Intestinal parasites may, in children, give rise to abdominal symptoms, which in their brusque onset and violent character, together with the consequent severe constitutional disturbances, closely simulate acute appendicitis. Instructive examples of this confusion, given by C. ARBORÉ-RALLY and METCHNIKOFF, are described in Chap. XI. The differential diagnosis rests chiefly upon the discovery of the ova of the parasites in the stools. It must be borne in mind, however, as is clearly shown in Chap. XI., that intestinal parasites may be associated with, and indeed may be the exciting cause of, acute appendical inflammation. The blood examination may be of great value in doubtful cases, as in helminthiasis a high grade of eosinophiles is frequently found, while in the early stages of acute appendicitis there is often a marked diminution or a total absence of these cells (SIMON, *Clinical Diagnosis*). As the infection terminates, however, the eosinophiles are relatively and actually increased (DAVID, *Thèse de Paris*, 1903).

Inflammation of Meckel's diverticulum (diverticulitis) has been several times mistaken for appendicitis. J. M. T. FINNEY (*Maritime Med. News*, 1907, vol. 19, p. 340) mentions a case where he operated for a fecal fistula supposed to have resulted from the spontaneous rupture of an abscess of the appendix. Operation proved that it was a case of inflammation of a Meckel's diverticulum.

ACTINOMYCOSIS.—The same author (*loc. cit.*) has operated on three cases of actinomycosis of the appendix with abscess. He calls attention to the great amount and wide extent of the induration in these cases.

LEAD COLIC.—In the absence of general symptoms of plumbism, lead colic may be mistaken for appendicitis, and vice versa. BERNARD (*Thèse de Paris*, 1901) refers to a case in which the appendix was removed on account of abdominal symptoms suggestive of appendicitis. The following year the patient suffered from an attack of an exactly similar nature, and it was then found that he was the subject of lead colic. JANEWAY (*personal communication*) had a case of lead colic in a plumber who had had his appendix removed because of pain in the abdomen. At the time Janeway saw him it was proposed to remove the colon for a neoplasm. Granular, degenerated, red blood-corpuscles being found in the urine, a poison of some kind was suspected. Iodide of potassium was given for a week, and when the urine for twenty-four hours was collected, lead was found in it. An attack of colic in chronic lead poisoning is often preceded by gastric or intestinal symptoms, particularly constipation. The pain is over the whole abdomen and is usually paroxysmal. There is often, in addition, a dull heavy pain between paroxysms, and there may be vomiting; attacks of pain with acute diarrhoea may also occur. Acute lead poisoning may present vomiting and pain in the abdomen, with gastro-intestinal symptoms of the most intense description, accompanied by collapse which may prove rapidly fatal. In lead colic, unlike colic due to inflammatory disease, there is an absence of general or localized tenderness, in fact, the pain is usually relieved by pressure. The pulse-

rate instead of being accelerated is retarded, and there is increased tension (RITZEL quoted by Osler). The blood examination is here of importance in the differential diagnosis. According to DA COSTA ("Clinical Hematology," 1901), there is often pronounced leucocytosis, especially in cases with acutely toxic symptoms, but granular basophilia of the erythrocytes can be detected even in the earliest stage of plumbism, while in appendicitis this does not occur. Acute poisoning may simulate acute appendicitis, which at the outset presents signs of an acute diffuse peritonitis accompanied by signs of collapse. In such a case the temperature, the pulse, and the leucocyte count may not present points of differentiation. As acute lead poisoning is usually the result of a large amount of poison taken accidentally or with suicidal intent, the history will usually give the clue. The most important cases are those in which there is coincident plumbism and appendicitis. A patient presenting general symptoms of lead poisoning may be seized with an attack of acute or chronic appendicitis, which is considered to be merely the usual abdominal symptom of plumbism. The chief points in the differential diagnosis are the localization of the pain in the right iliac fossa, the presence of diffuse or localized tenderness, and rigidity of the abdominal walls. The temperature is more or less elevated and the pulse accelerated. Leucocytosis, if present, is a valuable confirmatory sign. The detection of a mass in the right iliac fossa is, of course, positive evidence that the attack is not due to plumbism.

AFFECTIONS OF THE PERITONEUM AND MESENTERY. — Tubercular peritonitis, both in the chronic and the acute form, may simulate appendicitis. Many cases set in acutely with fever, abdominal tenderness, and the usual symptoms of an ordinary acute peritonitis, the predominating symptoms often being referred to the right iliac region. These cases are frequently mistaken for appendicitis with localized peritonitis. In other instances the onset is exceedingly brusque, with acute abdominal symptoms and marked constitutional disturbance, simulating acute perforative appendicitis with generalized peritonitis. A case described by ROUSSEAU (*Thèse de Paris*, 1901) is that of a child who awakened with sudden sharp pain in the abdomen, the maximum intensity of the pain being in the right flank. She vomited almost immediately, and at the same time several ascarides were passed *per rectum*. A few hours later she vomited some mucus. Twelve hours after the onset of the attack she was admitted to the hospital in a critical condition, presenting the typical *facies abdominalis*, cold extremities, rapid respiration, and extremely small pulse. The abdomen was distended, and palpation in the right flank elicited acute pain and muscular resistance. A diagnosis was made of probable peritonitis due to perforative appendicitis, and immediate operation performed. There was a small amount of serous fluid in the abdominal cavity and the serous membrane was covered with fine tubercular granulations. The child did not improve after the operation, but presented signs of increasing intoxication, and died on the sixth

day. An instance of the chronic form, given by TREVES, is the case of a boy, aged thirteen, admitted to the hospital complaining of pain in the right side and occasional vomiting. He declared that the pain began suddenly some months previously, being accompanied by vomiting and a tender swelling in the cæcal region, which had not entirely disappeared. An exploratory incision revealed a localized tubercular peritonitis, with evidence of extension over the general serous surfaces. The appendix appeared normal. The most characteristic features of the acute attack are the more moderate fever, the less acute abdominal tenderness, the more indefinite localization of the symptoms, the more frequent occurrence of fecal vomiting. None of these indications, however, are distinctive, and in some instances the differential diagnosis is impossible. Most important among the diagnostic points are the personal and hereditary antecedents of the patient.

Gonorrhoeal peritonitis may be mistaken for appendicitis. The history of gonorrhœa will serve to differentiate the two.

General peritonitis secondary to measles has been described by R. T. MORRIS (*N. Y. Med. Jour.*, 1899, vol. 1, p. 470) as being mistaken for acute appendicitis with general peritonitis. Operation showed the peritoneum thickened and infiltrated, while the abdominal cavity was filled with viscid lymph. Recovery was retarded by an attack of meningitis accompanied by pleurisy and pericarditis.

A case of lipoma of the mesentery, twisted on its axis and producing gangrene and perforation of the ileum, which were at first mistaken for acute perforative appendicitis, has been sent me by A. C. BERNAYS, of St. Louis. The patient, a girl six years old, was suddenly taken with severe colic followed by vomiting. There was an obvious tumor in the iliac fossa but little tenderness. The child was moribund when sent to the hospital, but was operated on as a last resort—too late, however, to save her life.

A mass of gangrenous omentum, causing acute abdominal symptoms, associated with shock, in a case reported by SPILLISSY, was operated on for supposed appendicitis.

Enlarged retrocaecal and retrocolic glands have frequently given rise to a diagnosis of appendicitis. The majority of these cases have been due to tubercular disease, but in a case reported by CONDAMIN and VORON (cited by Spillissy) the adenitis was of syphilitic origin. A unique case of typhoidal adenitis mistaken for appendicitis has been described by RICHARDSON (*N. Y. State Med. Jour.*, July, 1901). RUSSELL (*Mod. Med. Sci.*, Feb., 1902) reports a case of fatal vaccination infection which presented symptoms resembling acute appendicitis. The vaccination, on the right thigh, had apparently been followed by suppurative adenitis of the inguinal and iliac glands and diffuse fibro-purulent peritonitis.

DISEASES OF THE KIDNEYS AND URETERS. — Floating kidney has frequently been mistaken for appendicitis, and several instances

have been recorded in which the true condition was only discovered at operation. In a case described by MILLER (*Med. Rec.*, 1900, p. 353) the presence of a mass in the right iliac fossa, with a history of more or less constant pain extending over about a year, was very suggestive of appendical trouble. The occurrence of acute attacks ("Dietl's crises") characterized by severe abdominal pain, chills, nausea, vomiting, fever, and collapse in a patient who is not known to be suffering from floating kidney, may be very misleading. The kidney during these attacks is swollen, tender, and often less freely movable, while on account of the localized tenderness and the rigidity of the abdominal walls palpation may be difficult and unsatisfactory. The chief diagnostic feature is the characteristic shape of the organ together with its mobility, and in the ordinary cases the diagnosis is rarely doubtful. By making the patient relax thoroughly, especially when lying on the left side with the right thigh flexed, the kidney can be readily grasped and made to slip back into its normal position. Sometimes also a depression in the flank corresponding to the normal site of the kidney is plainly visible.

During the acute attacks the muscular rigidity is usually more diffuse and not so marked as in appendicitis, and the tenderness is often more severe posteriorly. The condition of the urine is sometimes an aid in the differential diagnosis. During acute renal attacks an excess of uric acid is common, but high-colored, scanty urine and the occasional presence of pus and blood may accompany either affection. Acute anuria may also occur in either, but with the subsequent voiding of a large amount of urine the renal pain is entirely relieved, while appendical symptoms are not affected. A diagnostic point of great significance is the frequent occurrence of floating kidney in neurasthenic women. A history of attacks of pain not always referred to the same region, or a history of intermittent hydronephrosis, indicates a movable kidney. Finally, in all doubtful cases, examination under ether narcosis will at once reveal the presence of a floating kidney. It is, however, of great importance to remember that the two affections frequently coexist, some observers believing that a large percentage of cases of chronic appendicitis is a constant accompaniment of right floating kidney. It is therefore essential in the presence of a floating kidney to exclude definitely the presence of appendicitis.

Renal calculus may produce symptoms closely simulating acute or chronic appendicitis. Renal colic due to the entrance of a calculus into the ureter may set in abruptly without apparent cause, or may follow a strain in lifting. It is described by OSLER as characterized by agonizing pain, which starts in the flank of the affected side, passes down the ureter, and is felt in the testicle and the inner side of the thigh. The pain may also radiate through the abdomen and chest and be very intense in the back. In severe attacks there is nausea and vomiting and the patient is collapsed. A chill may precede the outbreak, and the temperature may rise as high as 103° F. Perspiration breaks out upon the face

and the pulse is feeble and quick. Micturition is frequent, and occasionally painful, while the urine, as a rule, is bloody. The attack may not last longer than an hour; in other instances it continues for a day or more, with periods of temporary relief. There is usually tenderness on the affected side. If the calculus remains in the kidney there is usually a dull pain, often referred to the back. In some cases the pain comes on in acute paroxysms. Hæmaturia is common, but by no means constant, and the urine may be clear for days. There may also be intermittent attacks of pyuria. The distinctive features in the differential diagnosis are the situation and direction of the pain, the retracted and painful testicle, and the changes in the urine. When the calculus is in the lower portion of the ureter, just above the pelvic brim, and the pain and tenderness centre at this point, the diagnosis is sometimes exceedingly difficult. The X-ray examination is a most valuable diagnostic aid, but may lead to erroneous conclusions, particularly when a ureteral calculus is located in the iliac fossa.

Two interesting examples of the confusion that may exist between these conditions were sent me by Prof. D. GIORDANO, of Venice, Italy (see "Vermiform Appendix and its Diseases," p. 422).

Another case was sent me by A. J. OCHSNER, of Chicago (*personal communication*) (*loc. cit.*, p. 423).

BREWER (*Ann. Surg.*, 1901, vol. 33, p. 590) refers to three cases in which a diagnosis was made of appendicitis, but which proved to be ureteral and renal calculi.

Pyonephrosis may closely resemble acute or chronic relapsing appendicitis. C. P. NOBLE (*personal communication*) had a case in which the patient was operated on for supposed appendicitis, but the appendix was found to be normal, and a pyelitis the source of the trouble. The patient got well of the pyelitis while in bed recovering from the operation. The most distinctive features are the changes in the urine accompanying the acute attacks of pain, and the rigors, high fever, and sweats indicating a pyæmic condition. The position of the tenderness and the distinctly outlined tumor in the kidney region usually lead to a correct diagnosis. The presence of cystitis is a confirmatory sign of value in some cases. The fact that the renal or ureteral suppuration may be secondary to appendical disease as in LENZMANN's and in TREVES' cases should be borne in mind. In chronic cases of persistent pain in the right side where a definite diagnosis cannot be made, I have found the following procedure of value in excluding renal disease: With the patient in the knee-chest posture a cystoscope is introduced, and through it a suitable catheter is passed into the ureter and up to the kidney. The pelvis of the kidney is then distended with sterilized water, and as soon as its normal capacity (shown by the measured resistance) is exceeded there is more or less severe pain. If this pain is similar to the pain from which the patient has suffered, there is fairly conclusive evidence that the kidney is at fault, and vice versa.

Perinephritic Abscess. — As suppurative peri-appendicitis frequently involves the perirenal tissue and is one of the common causes of perinephritic abscess, the differential diagnosis depends chiefly upon the history of the events leading up to the attack. If the onset is marked by the usual symptoms of appendicitis, the diagnosis is clear; while with a history of injury to the lumbar region or of a pre-existing kidney affection, followed by the sudden or the insidious development of the abscess, there is usually no difficulty in determining the origin of the disease. SPILLISSY refers to a case in which a gonorrhœal ureteritis, secondary to a prostatitis, simulated acute appendicitis.

Renal tumors are rarely mistaken for appendicitis, but when the appendix ascends towards the lower pole of the kidney, an exudate may form in this region and present all the characteristics of a renal tumor. The chief features upon which the diagnosis rests are: The gradual, insidious development of the tumor, its progressive growth, the slow onset and increase of pain, its steady character, and the fact of its being located chiefly in the loin. The urinary changes are of great importance, especially the occurrence of hæmaturia, which is a fairly constant accompaniment of renal tumors, but is comparatively rare in appendical disease, and even if present is very seldom persistent. An example of a renal tumor mistaken for appendicitis is given by W. H. HARSHA (*Ann. Surg.*, March, 1902), in which a man, forty years of age, had for some time presented the usual evidences of a large appendical abscess, which finally ruptured, producing a consequent general peritonitis. On making an incision over the site of the appendix, a solid mass was encountered, which proved to be a large tumor of the kidney containing an abscess which had ruptured into the peritoneal cavity. Microscopic examination showed that the tumor was a fibro-sarcoma.

DISEASES OF THE GALL-BLADDER. — Every surgeon of wide experience has had cases in which it was exceedingly difficult, and often impossible without an exploratory section, to differentiate between appendicitis and acute or chronic diseases of the gall-bladder and its ducts. **Acute cholecystitis** sets in with severe paroxysmal pain, situated most commonly in the right side of the abdomen, or in the region of the liver, but frequently in the epigastrium and sometimes in the ileocæcal region; "nausea, vomiting, rise of temperature and pulse, abdominal distention, rigidity, general tenderness becoming localized, quickly follow." Intestinal obstruction is often a prominent symptom. The symptoms may not be definitely localized in inflammation of the gall-bladder; while, on the other hand, if the appendix is in a high retro-colic position, the maximum intensity of the pain and tenderness may be referred to the hypochondriac region. With a history of previous attacks of cholecystitis, or if the attack occurs during convalescence from typhoid fever, cholecystitis may be suspected.

Empyema of the gall-bladder, in addition to the symptoms of cholecystitis, presents a definite tumor in the right side,

which may increase the diagnostic difficulties. OSLER records the case of a woman admitted to the hospital with a history of very sudden onset of severe pain three days previously in the right side of the abdomen, and with an ill-defined tumor mass low down in the right flank. She was transferred at once to the surgical side for operation for supposed appendicitis, when the condition proved to be an acutely distended and inflamed gall-bladder, almost on the point of perforating. The tumor in appendiceal inflammation can be distinguished by the presence of a tympanitic zone between the lower border of the liver and the mass, while the distended gall-bladder disappears under the liver and the dulness over the mass merges into the liver dulness. In gall-bladder inflammation there is almost invariably a tender spot a little above and to the right of the umbilicus.

Hepatic colic, due to the entrance of gall-stones into the cystic or common duct, may present many points of resemblance to acute appendicitis. The attack sets in suddenly with agonizing pain, often associated with rigor, fever, and abdominal rigidity. The pain, as a rule, is located in the right hypochondrium and the epigastrium radiating toward the scapula, while in appendicitis the pain usually extends towards the umbilicus and downward. Tenderness under the costal margin is characteristic of inflammation of the gall-bladder and its ducts. In hepatic colic an initial rigor is more frequent, the pain is more intense, and the nausea and vomiting are more continuous from the first. SONNENBURG enumerates as the most distinctive features of gall-bladder inflammation and biliary calculus: the high position of the exudate; the slight constitutional disturbance; and the direction of the dulness on percussion, especially its passing into the liver dulness. Icterus may occur or may be absent in either case.

Rupture of the gall-bladder occurring suddenly without previous evidence of any disease of the gall-bladder has been mistaken for acute perforative appendicitis. Several examples of this mistake are recorded. G. M. POND (*Med. Rec.*, April, 1898, p. 585) relates the case of a man, forty-five years of age, who, while lifting a heavy weight, was seized with severe epigastric pain and collapse. A diagnosis of appendicitis was made. The next day he had but a slight rise of temperature; his pulse was 120; his face anxious; the pain was localized over McBurney's point and the tenderness well marked. The right rectus muscle was rigid. When the abdomen was opened a quart or more of bile gushed out, and the attack was found to be due to rupture of the enlarged, distended gall-bladder. E. G. FIELD of Norfolk, Va. (*personal communication*), saw a case of rupture of the common duct which closely simulated acute perforative appendicitis. A physician, aged fifty-two years, was attacked with sudden severe pain in the right side of the abdomen, extending from the region of the liver to the groin. There was great tenderness over this region and the right rectus muscle was tense. There was considerable meteorism, which gradually increased until the respirations were greatly interfered with. The temperature was subnormal, the pulse

small and weak. The patient died about thirty-six hours after the onset of the attack, in great agony. Autopsy showed rupture of the common duct with beginning general peritonitis.

In considering the question of the differential diagnosis between appendicitis and diseases of the liver and gall-bladder the surgeon has not simply to determine whether he is dealing with a case of appendicitis or of a hepatic or gall-bladder disease; he has also to consider that important group of cases in which affections of the organs coexist, particularly the cases in which the disease of the liver and gall-bladder is secondary to the appendical inflammation. In the preceding sections the frequency of these complications has been emphasized, and attention has been called to the fact that pylephlebitis and liver abscesses may be the result of an unsuspected subacute appendicitis. The diagnosis of the secondary condition in these cases is easy, but the primary affection is often completely masked. I have met with two or three instances in which the persistent pain in the right hypochondrium, associated with jaundice, led to a diagnosis of cholelithiasis or cholangitis, and at operation a chronic appendicitis was found, with adhesions involving the gall-bladder and compressing the ducts. Not infrequently gall-stones and cholecystitis have existed independently of the appendical disease, as in the cases cited in Chap. X. When the association of the two ailments is not recognized, and only one is cured at the first operation, a second operation has sometimes been necessary for the complete relief of the symptoms.

PANCREATIC DISEASE.—In acute pancreatitis the sudden intense epigastric pain, abdominal distention, constipation, and vomiting may at the outset suggest appendicitis. The most important differences between the two conditions are: the more agonizing and persistent pain in pancreatitis, the tenderness on pressure over the left costal margin, and the profound prostration, which is often associated with marked cyanosis. The age of the patient, a history of alcoholism, and more particularly a history of gall-stones are important in the diagnosis. The temperature is usually normal, but the pulse accelerated. The presence of fatty stools is, of course, conclusive evidence of pancreatic disease. Suppurative pancreatitis is accompanied by fever and may closely resemble peritonitis due to a ruptured appendix. BREWER (*loc. cit.*) reports the case of a man fifty-three years old, who had presented abdominal symptoms for a year, and gave a history of peritonitis occurring seventeen years previously. He was suddenly seized with abdominal pain accompanied by vomiting, fever, and sweats. The abdomen was distended and generally tender. At operation the only evidence of disease was the presence of small white spots covering the omentum. At autopsy the pancreas proved to contain numerous small abscesses.

GYNÆCOLOGICAL AFFECTIONS.—Diseases of the pelvic organs in women form the most important class of cases liable to be mistaken for appendicitis, and vice versa. The differential diagnosis of these conditions will be fully considered in Chap. XXI.

INTRAMUSCULAR ABDOMINAL ABSCESES.—These have been mistaken for appendicitis with localized peritonitis. They are distinguished chiefly by the absence of intestinal symptoms, the position of the swelling, and sometimes its movement with the abdominal walls. Suppurative appendicitis is not uncommonly accompanied with edema and infiltration of the overlying abdominal muscles, but in such cases there are the distinctive signs of a deep-seated affection and the history of appendical inflammation. The primary affection may subside, leaving only the superficial abscess, as in a case admitted to the gynæcological ward of the Johns Hopkins Hospital, where a brawny, diffuse swelling in the abdominal wall over the right iliac fossa was found to be an intramuscular abscess. This was freely opened and drained, when complete recovery followed, but later on, it was necessary to remove the adherent appendix on account of persistent pain.

ACUTE PSOITIS.—This condition may set in with sudden severe pain and tenderness in the right iliac region, suggesting an acute appendicitis. The pain, however, extends down the thigh and to the genital organs. The thigh is flexed and rotated inward. The absence of intestinal or peritoneal symptoms and the usual failure of the acute initial symptoms of appendicitis are the distinguishing points in the diagnosis; the chief difficulty being involvement of the psoas muscle in appendicitis, but in such cases other confirmatory symptoms are usually found.

AFFECTIONS OF THE VERTEBRÆ AND OF THE HIP-JOINT.—Appendicitis developing insidiously and accompanied by gradual flexure of the thigh, or with pain in the lumbar region and an ill-defined mass, may closely simulate a lumbar abscess or a coxitis. I have not met with a case of genuine vertebral or hip-joint disease in which the question of differential diagnosis from appendicitis caused great perplexity after a thorough examination had been made. Cases of erroneous diagnosis in hip-joint disease in children have, however, been reported. The history of the patient, the gradual onset of the attack, the absence of intestinal symptoms, the location, direction, and character of the swelling, and usually the evident deformity, are indications which should render the diagnosis sufficiently clear. The subject is fully considered in Chap. X.

A recent case of my own is cited here as illustrative of the difficulty in some of these cases.

Miss E. M., age nineteen, September 5, 1907. The patient came into my office complaining of pain in the right hip of five years' duration and walking with a slight limp. There was no history of trauma and the personal and family histories were negative. The pain was described as situated between the right sacro-iliac joint and the trochanter, running down the front of the right thigh to the right knee and increased by stooping forward. The suffering varied in amount, being more acute at some times than at others; pressure directly over the sacro-iliac joint caused intense pain. The "sacro-iliac test" was present on the right side; there was no atrophy of the right thigh. A sacro-iliac support was placed round the pelvis, on the supposition that there was relaxation of the joint, and a partial improvement followed. As the improvement was not complete, however, and as palpation over McBurney's point always elicited a sciatic pain, I removed the appendix about two weeks after she was first seen. It was 8 cm. long, obliterated at its tip, and

bound down along the psoas muscle by basal adhesions. These were entirely removed, with complete relief of the pain. There had been no history of abdominal attacks, but there had been some nausea occasionally for the last five years.

Acute osteomyelitis may, however, set in so brusquely and with such marked abdominal symptoms that at first considerable confusion may exist as to the diagnosis.

J. B. DEEVER relates a case of gangrenous appendicitis in which, on account of the history of injury and the strongly flexed, abducted right thigh, which could not be moved without severe pain, a dislocation of the hip was suggested, although the pain did not begin until the day after the injury was received. The presence of marked abdominal distention, tenderness, and rigidity disclosed the true nature of the attack.

HYSTERIA AND HYPOCHONDRIASIS.—These conditions must be eliminated from the diagnosis in some cases of suspected appendicitis, but it is necessary to be always on guard against assuming a nervous manifestation in the presence of a true inflammation of the appendix. The distinctive features in the differential diagnosis of acute attacks are: the absence of fever and leucocytosis, and the disappearance of local tenderness and rigidity when the patients' attention is diverted. The common occurrence of digestive disturbances in neurotic individuals makes the recognition of chronic appendicitis more difficult. The palpation of the thickened appendix is sometimes possible, and this is, of course, conclusive. LE ROY BROWN (*Amer. Jour. Obst.*, July, 1904) agrees with MANTON of Detroit in believing that visceral delusions in the insane are often founded upon the presence of some pathological condition. He relates a case of a woman with the delusion of evil spirits in the abdomen, from whom a large, inflamed appendix was removed. Neuralgia of the nerves of the right side of the abdomen may simulate appendicitis, but a careful examination will not fail to reveal the true nature of the ailment.

ANGIONEUROTIC OEDEMA.—J. M. T. FINNEY (*loc. cit.*, p. 345) reports an interesting case of this rare disease being mistaken for appendicitis. In angioneurotic oedema a swelling may appear in the region of the appendix as well as in any other portion of the body. Pain in the abdomen is often situated in the neighborhood of the appendix; the stomach rejects food and is tender to palpation. All the secretions of the body are greatly diminished. The history of the case should clear up the diagnosis. The disease is apt to be hereditary and there should be a history of the occurrence of similar symptoms in the past.

INTRA-THORACIC AFFECTIONS.—The importance of recognizing the fact that pneumonia and pleurisy, particularly in children, may be ushered in with acute abdominal symptoms, has recently been emphasized by numerous cases, reported by BARNARD, RICHARDSON, HERRICK, and others, in which the diagnosis at first was doubtful, and in a considerable number operation was performed for supposed appendicitis. Out of 24 cases of pneumonia with early symptoms referred to the abdomen, collected by GARREAU (*Thèse de Paris*, 1903), 5 were submitted

to abdominal section for acute appendicitis. Pleurisy or basal pneumonia with involvement of the diaphragmatic pleura seems especially liable to excite acute abdominal symptoms, but a pneumonic focus limited to the right upper lobe may possibly provoke similar phenomena, and in a case where HERRICK was called upon as to the advisability of operation for appendicitis, the affection was located in the left lower lobe. In this instance, however, the symptoms simulated a general peritonitis supposed to be of appendical origin, although the right iliac region was not especially involved. The attack set in brusquely with severe pain in the abdomen, fever, nausea and vomiting. In such cases the pain may at first be general, and is sometimes associated with marked distention, tenderness, and rigidity. When there is a history of previous trouble in the right iliac region, as in a case described by MORRIS (*N. Y. Med. Jour.*, 1899), the clinical picture is still more confusing. The most important distinguishing features are: the sudden high temperature, which often ranges from 103° to 106° F., and is very unusual in appendicitis, together with the rapid respirations, which are often increased out of proportion to the abdominal symptoms. The tenderness and rigidity are usually less pronounced than in true abdominal inflammation. HERRICK has observed that the cutaneous hyperæsthesia is often excessive, while steady, quiet, deep palpation will not increase the pain; and it has been noticed by BARNARD that the abdomen may be seen to yield slightly at the beginning of inspiration. The high leucocyte count may be a valuable confirmatory sign in doubtful cases. DA COSTA states that the leucocytosis appears early, at or soon after the initial chill, and that the average "first count" is 22,693, including cases which fail to develop an increase. In appendicitis, on the other hand, the increase is rarely so rapid. However, the main safeguard in the diagnosis, as expressed by HERRICK, is to bear in mind the possibility of a thoracic origin for the abdominal symptoms. It will then generally be found that there are some thoracic symptoms, and a careful examination of the chest will reveal some loss of motion, and, on auscultation, one or other of the characteristic signs, albeit extremely slight, will usually be detected.

Another source of error in the diagnosis under these circumstances is the occasional coexistence of appendical and thoracic disease, in which case, in the presence of an undoubted pneumonia, it may be difficult to determine whether the abdominal symptoms are merely reflex or are due to a complicating appendicitis. W. FINDER of Troy, N. Y. (*personal communication*), saw a patient suffering from an evident pneumonia and at the same time presenting typical symptoms of appendicitis; the gangrenous appendix was removed by HOUSTON, and the patient recovered from both affections. In cases, however, where there are unmistakable symptoms of acute thoracic disease and obscure symptoms of appendicitis, the latter are almost invariably reflex in origin. There is always danger, nevertheless, of too great conservatism in doubtful cases, and, as RICHARDSON remarks: "a heavy responsibility rests upon those who advise delay

when the symptoms point to a general peritonitis, even if those symptoms are not quite what they should be in typical cases. The real cases of appendicitis and of general peritonitis as compared to those of an atypical typhoid, a latent pneumonia, or some other unusual simulating lesion, are a hundred to one."

ABDOMINAL ANEURISM.—OSLER has known of three cases, within the last few years, in which patients were seized with sudden abdominal acute pain and a diagnosis of appendicitis was made. At operation an abdominal aneurism was opened.

MEASLES.—J. M. T. FINNEY (*loc. cit.*, p. 340) mentions a case where he was called into the country to see a girl of fifteen, who had been complaining for three days of severe abdominal pain, located primarily about the umbilicus and later in the right iliac fossa. Her temperature and pulse were both elevated, there were marked tenderness and slight muscle spasm over the right rectus in its lower third, but no tumor. The attacks had begun with vomiting and constipation. The patient was far from surgical aid in case of emergency, and operation was performed. The appendix was found comparatively normal, and the next day the patient's skin was covered with a profuse rash of measles, and the disease ran a typical course to recovery.

CHAPTER XII.

THE LEUCOCYTES IN APPENDICITIS.

THROUGH the researches of many investigators, it is established that a well-marked hyperleucocytosis is one of the most constant concomitants of those cases of appendicitis in which destructive lesions characterize the course of the disease. In simple catarrhal cases, on the other hand, the absolute leucocyte count may show but slight deviation from the normal, and in a certain percentage no increase whatever has been found. The lesion in the appendix in this latter class is often so trivial that the diagnosis appendicitis seems scarcely warrantable; I strongly suspect that the relatively large number of catarrhal cases of appendicitis which some observers have reported as not associated with any increase of the leucocytes, would be much reduced if the clinical diagnosis had always been controlled by an adequate histological examination.

Unfortunately, the absolute count still occupies the attention of most laboratory workers, while the differential count receives but little consideration; but this should not be the case, as the differential count furnishes information in many respects far more valuable than the absolute. If the number of leucocytes pro unit of blood were as constant as that of the red cells, then the absolute count might possibly suffice to determine slight deviations from the normal, even though the leucocytic formula is made up of five different components. But as a matter of fact the total number of the leucocytes is subject to fairly wide variations even under normal conditions, so that conclusions drawn from an absolute count alone may prove entirely erroneous. While on the one hand in the majority of normal individuals an absolute count of from 5000 to 7500 is the rule, on the other in those who are in a lower state of nutrition than the average, lower values are also normally present (3000-5000), while higher figures (up to 10,000) may be found in unusually vigorous and well-nourished persons. It thus becomes clear that an absolute count of 8000-10,000 in a poorly developed and ill-nourished individual might really indicate a decided hyperleucocytosis. It is therefore scarcely correct to speak in a general way of "normal" values in simple catarrhal cases of appendicitis, unless we have some knowledge of the normal value in the concrete case, and unless a careful histological examination actually shows the existence of a morbid process.

I have personally employed the differential count in routine blood work for many years, and have come to the conclusion that a distinct deviation from the normal occurs in every case of appendicitis in which careful examination of the appendix shows a definite lesion. I am simi-

larly convinced of the validity of the converse proposition,—namely, that in all cases of appendicitis of the usual bacteriological types a differential leucocyte count will reveal a distinct deviation from the normal formula.

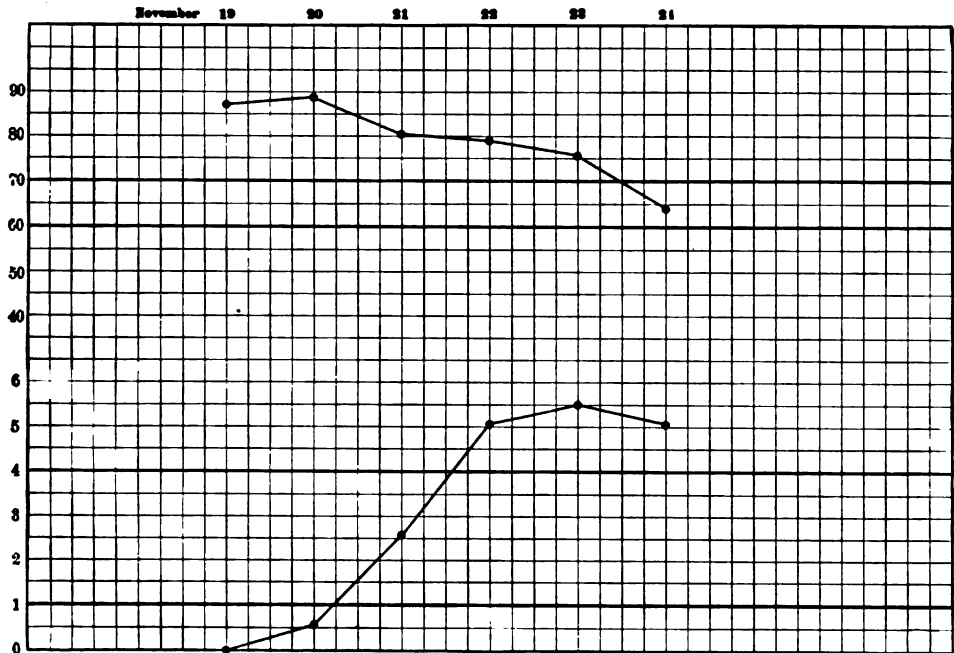
While the absolute leucocyte count in the simple catarrhal cases is thus of subordinate value only, this holds good even more forcibly for the more serious cases in which definite destructive changes are taking place. Reliance upon the absolute count alone may here give rise to disastrous consequences. High values, it is true, indicate in a general way that the disease is active, and increasing values—where repeated examinations are made—that the disease is progressive. Low counts or falling values, on the other hand, may indicate either that the disease is abating, or that the infection is unusually severe or that perforation with general peritonitis has developed. The clinical symptoms will suggest, in most cases, what interpretation is to be given to low or falling values, but exceptional instances are seen now and then in which pain, pulse, and temperature do not indicate what is actually taking place. In these cases again the differential leucocyte count will tell the true story. As a result of my studies in septic conditions, I have been led to attach especial significance to the interrelation between the neutrophile and the eosinophile count, and have designated as “septic factor” an increase of the neutrophiles when associated with a decrease or absence of the eosinophiles. In my experience this septic factor is never absent in the usual bacteriological types of appendicitis, so long as the disease is active, no matter what the total count may be, and I have accordingly come to look upon it as essential to the diagnosis of the disease.

The value of the septic factor becomes especially apparent in those cases in which a fall following a previous rise in the total number of the leucocytes occurs and in which there may be doubt as to the course to be pursued. A continued high value of the neutrophiles, with absence or decreased numbers of the eosinophiles, is then usually an unfavorable symptom, as it shows that with a continued infection the process of resistance is below par. A decrease of the neutrophiles and a return of the eosinophiles to normal values, on the other hand, is always a favorable omen; during convalescence it may happen that the eosinophiles increase somewhat beyond the maximal normal figures, and coincidentally a moderate grade of lymphocytosis is by no means uncommon.

The most satisfactory insight into the defence of the body is, of course, obtained if both the absolute and relative values are known, and especially if examinations can be made at frequent intervals. If, however, for any reason only one examination can be made, and it should be necessary to choose between an absolute and a relative count, preference should be given to the latter. The differential count is essentially of diagnostic, and the absolute of prognostic significance.

An analysis of a series of 186 cases shows that, *cæteris paribus*, the highest values (15,000–30,000) are met with in those cases in which pus formation has taken place. This has given rise to the erroneous impression

that it is possible by means of the absolute count to decide in a given case whether an abscess has developed or not. Both surgeons and laboratory workers have been slow to learn that a high leucocyte count may indicate the existence of pus but does not necessarily do so. In the past much misunderstanding has arisen on this point and a wordy warfare has been carried on between certain surgeons and laboratory men. DEEVER has expressed warnings against "the tendency to replace the bedside by the laboratory as the point from which to make the diagnosis." In our estimation, such danger does not exist, but it is highly desirable that surgeons generally should learn to interpret those findings of the laboratory



The upper curve has reference to the neutrophils (normal variations 60-70 per cent.), the lower to the eosinophiles (normal variations 1-4 per cent.).

The curve illustrates the return to normal of the eosinophiles and neutrophils following operation for appendicular abscess. Mrs. S., U. P. I., Nov. 19, 1906.

which represent important advances in our diagnostic methods and to give them the same recognition that they are willing to bestow upon other methods of precision.

While high leucocyte values are thus seen in suppurative cases, it is interesting to note that hyperleucocytosis of marked grade (15,000-20,000) may also occur in cases in which the appendix shows but slight lesions. This is difficult to explain, unless we assume the existence of a toxæmia of considerable intensity, emanating from a bacterial nidus which may be located in the appendix and which would have given rise to a suppurative lesion had the appendix not been removed; but I dare say that some of these cases are essentially due to fecal stasis in the cæcum and the incidental findings about the appendix are of secondary importance. Such

occurrences in my experience are especially frequent in children and may give rise to much preoperative anxiety. The neutrophiles in these cases follow the general ascent in the total leucocyte curve, while the eosinophiles, as in the suppurative cases, are much diminished or absent.

As stated above, my investigations into the occurrence of the septic factor in appendicitis have led me to look upon this as one of the most constant features of the disease and as one of the utmost diagnostic importance. In its absence I unhesitatingly rule out the diagnosis of an appendicitis of the common bacteriological types. In quiescent cases, as we should expect, no information can be derived from an examination of the blood, beyond the knowledge that an active inflammatory lesion does not exist. In those cases also in which an abscess of the appendix is present which is walled off so effectively as to give rise to no clinical symptoms whatever, abnormal blood-findings may likewise be absent; but such cases are rare. I have repeatedly seen instances in which a mass could be palpated in the right iliac fossa and in which no material increase in the total number of the leucocytes was demonstrable, but I have yet to see a case in which an abscess existed and the differential count was normal.

In typhoid appendicitis the septic factor may be absent. I have a record of but one case in which a differential count was made, and I cannot, of course, generalize from this. The case, however, is of interest and is worth reciting.

R. D., a boy of 15, was admitted to Dr. Finney's service (U. P. I., No. 4884, Nov. 26, 1906) with a history of general malaise for ten days previous to admission, considerable abdominal pain, and some distention. The attending physician found it impossible to differentiate between typhoid fever and appendicitis until the local symptoms had become so pronounced that there could scarcely be any question of an active appendicitis. The absolute count at that time showed 11,000 cells, of which 9.5 per cent. were small mononuclears, 16.5 large mononuclears, and 73.0 per cent. neutrophiles. At operation, which was performed immediately upon admission, the appendix was found bound down by fresh adhesions, its tip necrotic and lying in an abscess cavity. Upon the basis of the differential count and in view of the conditions found at operation, I expressed the opinion that the case was one of appendicitis complicating typhoid fever. During the first week following the operation the temperature ranged between 99° and 105° F. On December 3d the Widal test showed definite clumping and almost complete loss of motility, with a dilution of 1:40, at the end of thirty minutes. Subsequently pylephlebitis developed, the staphylococcus aureus was isolated from the blood, and the blood picture became typical of an infection with the common pus organisms, the total number rising to 44,400 with the septic factor perfectly pronounced. It is interesting to note that on December 13th, when the leucocytes numbered 43,700, a positive Widal reaction was again obtained. Death occurred December 18th, but no autopsy could be secured.

The only exception to the rule that the septic factor is a constant symptom of an active appendicitis of the usual bacteriological types, which has come to my notice, occurred in a case of a coincident trichinosis, the history of which was briefly related to me by the late Dr. D. G. J. Campbell of Halifax, Nova Scotia. The patient came to operation with the clinical picture of an abscess of the appendix, while the differential count showed an excessive number of eosinophiles (over 10 per cent.). An abscess was found. The patient died subsequently, and at autopsy an extensive trichinosis was discovered.

An exceptional case like this, however, does not lessen the value of the septic factor in the diagnosis of ordinary cases, and for practical purposes I insist that the diagnosis of active appendicitis is not justifiable unless a polynuclear increase with a material decrease or absence of the eosinophiles can be established, no matter what the absolute count may be. It is hardly necessary to cite individual cases to illustrate altogether negative findings at operation in which the differential count had shown normal percentage values, but it may be well to detail a few cases in which the differential count ruled out an appendicitis and attracted attention to some other pathological condition.

Joseph M., age ten (children's ward, U. P. I., Nov. 4, 1907). Four weeks before, while running after a street car, he had fallen, striking the right side of his abdomen and the right hip; the fall caused a good deal of pain at the time, but after an hour or so he went home feeling quite well. During the following night he was seized with a severe pain in the region where he had been struck by the fall, radiating down into the right leg. Pain and soreness did not subside very much, and in the course of the following week there were several attacks in which the pain was very severe, with soreness over the entire abdomen. On admission his temperature was 102.5° ; he lay in bed with the right leg flexed on the thigh and complained of pain when any attempt was made at extension. On deep palpation of the right iliac fossa, there was marked tenderness with muscle spasm and it was thought that a fairly large mass could be felt. With these symptoms and a total leucocyte count of 19,000 the diagnosis of an abscess of the appendix naturally suggested itself. The differential leucocyte count, however, showed absence of the septic factor. At operation, which was performed by Dr. Carr, the appendix was found normal, but on opening the peritoneal cavity a mass was encountered in the right iliac fossa, plastered up against the venter illi and extending upward and forward, where it became continuous with healthy omentum which was readily recognized by its blood-vessels. The resected omental mass was about one-half the size of the palm of the hand, red with hemorrhagic areas, and composed of inflammatory tissue with isolated areas of flat and thrombosed vessels.

Mrs. J. F. S., age forty-nine (Dr. Finney's service, U. P. I., Nov. 25), with the following history. For the past year she had had rheumatic pains in various joints without any definite swelling. For ten weeks previous to admission she had been confined to bed, supposedly with typhoid fever; there had been no chill and no septic symptoms, the temperature, according to the attending physician, running a fairly typical course. For six weeks before admission it was noticed that her right kidney seemed enlarged; no urinary examination was made, however, until about a week later, when a little albumin, casts, and some leucocytes were found. A few days later she had a distinct chill. A mass was then discovered in the right side of the abdomen, and the question arose whether this was due to an abscess of the appendix or of the kidney. The leucocytes just before operation were 18,000, and the differential count showed 19 per cent. of small mononuclears, 9.5 of large mononuclears, 71.5 of neutrophils, and no eosinophiles. With a leucocytosis of this grade and absence of the septic factor, a common abscess of the appendix was ruled out. It was suggested that a manifest tendency to a common neutrophilic hyperleucocytosis was held in check by the action of some organism which itself does not tend to produce a neutrophilic increase, and without any knowledge of the typhoid history of the patient the diagnosis of a typhoidal infection was tentatively made. A McBurney incision showed that the mass was retroperitoneal; on incision into the right flank, a large thin-walled cystic kidney was found, which on puncture discharged large quantities of thin, watery, grayish, odorless fluid. On bacteriological examination the typhoid bacillus was isolated in pure culture. The temperature, which was nearly 105° on admission, fell to 101.5° within 24 hours after operation, and was normal at the end of ten days; the convalescence was uninterrupted.

R. G., age twenty-nine (Dr. Finney's service, U. P. I., No. 4973, Jan. 4, 1907). About three weeks before the patient began to feel a pain in the abdomen under the right costal border and low down in the back of moderate severity, not constant, and more frequent at night. There had been no jaundice, nor any blood in the urine, and no nausea, vomiting, fever, or chill, but a loss of eighteen pounds in three weeks. An examination of the

abdomen showed that it was a trifle fuller in the lower right quadrant, where a firm mass was distinctly palpable. The leucocytes were not increased in number; the differential count showed 5.0 per cent. of small mononuclears, 13.3 large mononuclears, 78.3 neutrophils, 2.0 eosinophiles, and 1.5 per cent. basophiles. An abscess of the appendix of the usual type was eliminated upon the basis of the normal eosinophile and basophile values (latter being also constantly much diminished or absent in the usual infections with pus organisms), so that the diagnosis was left open between tuberculosis, carcinoma, and syphilis. The temperature from January 4th to the 7th varied between 99.4° and 101.5°; on the 7th at midnight 3 mgrms. of tuberculin were injected, but there was no reaction. At operation the mass was found to involve the appendix, cæcum, and distal portion of the ileum; it contained a small amount of pus, with tubercle bacilli in enormous numbers.

Mrs. H., about fifty years of age, was a patient of Dr. N. R. Gorter. I examined her blood first in the spring of 1904, when she complained of various neurasthenic symptoms and seemed somewhat anæmic. I was much struck at the time with a remarkable increase of the large mononuclear elements, and remarked to Dr. Gorter that I had seen such large mononuclear values repeatedly in malignant disease. During the spring of 1905 she began to complain of attacks of pain in the lower abdominal zone occurring at increasingly frequent intervals; on March 29th a mass was discovered in the right iliac fossa. Her leucocytes then numbered 5000, and a differential count again showed a large percentage of large mononuclears and absence of the septic factor. The diagnosis carcinoma of the cæcum was confirmed at the operation, which was performed by Dr. T. S. Cullen.

While hyperleucocytosis and the septic factor may thus be viewed as constant symptoms of appendicitis at some time during the course of the disease, it must not be forgotten that both are merely the expression of an inflammatory reaction of a certain type, and neither is indicative of inflammation of any one organ. The question of appendicitis will therefore be considered only if there are other symptoms which point to disease in the right iliac fossa or its contiguous structures. Liver abscess, suppurative cholecystitis, cholangitis, pyelonephritis, endometritis, parametritis, oöphoritis, and certain cases of purulent cystitis are thus all similarly accompanied by a neutrophilic hyperleucocytosis with hypo- or an-eosinophilia, in so far at least as infection with the common pus organisms is concerned. In typhoid infections, on the other hand, hyperleucocytosis is only exceptionally seen, and after the first days there is a distinct tendency toward lymphocytosis and splenocytosis, which becomes more and more pronounced as the disease progresses and after the first week or ten days is accompanied by hypoleucocytosis of a more or less intense degree.

Tubercular infections in the early stages of the disease almost always show a distinct lymphocytosis, with frequently maximal eosinophile values, while later on, when a secondary infection with the common pus organisms has taken place, a neutrophilic increase is commonly seen; it is interesting, however, to note that even then, as in the case of tubercular cæcitis related above, the eosinophiles show a strong tendency to persist.

In gonococcus infections a moderate grade of eosinophilia is occasionally seen, but is apparently not a constant factor.

It is important to note that fecal stasis is not associated with the septic factor, although a moderate grade of leucocytosis may be observed. This should be borne in mind in doubtful cases, as errors in this respect are no doubt responsible for some unnecessary operations.

In non-inflammatory tumors, finally, hyperleucocytosis as well as the septic factor is absent.

CHAPTER XIII.

APPENDICITIS AND TYPHOID FEVER.

IN typhoid fever the great and immediate source of anxiety to the watchful physician is the possibility of profound toxæmia or septicæmia, of hemorrhage, or of perforation. Aside from these grave complications, however, a host of lesser ills are liable to arise intercurrently. For example, on the right side of the body there lies a chain of organs, extending from the liver to the pelvis, whose links are the gall-bladder, the renal pelvis, the vermiform appendix, and the urinary bladder, any one of which is liable to become the source of an infection during the typhoid attack, long outlasting the original disease. Only one of these organs, however, the appendix, is apt to give rise to an acute disturbance in the midst of the fever. Infections of other organs, resulting in cholecystitis, pyelitis, and cystitis of the urinary bladder, manifest themselves as a rule at a later date, and become most prominent as sequelæ more or less remote. Inflammation of the appendix is an intercurrent affection which is liable to assume its greatest importance at the very beginning of the fever, or else when it is at its height.

If the typhoid patient is seized with an appendicitis, it is manifestly of the utmost importance to recognize the fact promptly, and in suitable cases to interfere for his relief, in order that the vital powers, already taxed to their utmost, may not be reduced to their lowest ebb by two coincident exhaustive conditions. The decision whether or not to institute operative proceedings for an appendicitis developing in the course of typhoid fever becomes, therefore, one of the gravest responsibility. On the one hand, the surgeon has to bear in mind that an appendicitis under these conditions is woefully like a powder magazine attached to a lighted fuse, which may go out quickly, but may, on the contrary, explode the mine at any moment unless the fire is extinguished by prompt interference at all hazards. Yet on the other hand, if the surgeon is overzealous in operating, and interferes merely because some of the symptoms of appendicitis are present, the event may prove that his interference was unnecessary, and he will then have to endure the chagrin of finding that he has added a useless and serious operation to the gravity of an already distressing situation. Moreover, the man who makes such a mistake cannot hope to escape the reproach of the family, and should the patient die at any time during the course of the disease, the natural tendency of the human mind to find relief from sorrow in anger will almost

certainly bring upon him the blame for the fatal result. The responsibility of a surgeon summoned to decide for or against operation under such circumstances has been graphically described by M. H. RICHARDSON (*Bost. Med. and Surg. Jour.*, Jan. 9, 1903). "Operations during the course of typhoid, even those operations which in themselves are comparatively slight, have a high mortality. The surgeon must be always on his guard lest he fail to recognize typhoid fever not only in its ordinary forms but in its unusual and atypical aspects, and subject his patient to an operation, which, even if apparently made necessary by the clinical evidence, is entirely unjustified by the pathological findings."

History.—The condition of the vermiform appendix in typhoid fever seems first to have received attention at the hands of a Frenchman, JADELOT, in 1808 (see also Chap. I, p. 2). In describing the case of a boy of thirteen, who died of a "*fièvre adynamique*," accompanied toward the close by symptoms of ataxia, the writer says that the autopsy showed a lesion at the end of the ileum exactly like those which M. Petit, at the *Hôtel Dieu*, attributed to the fever called "*entero-mésentérique*," while the different parts of the intestine were found filled with lumbricoid worms, four of which occupied the enlarged cavity of the appendix, lying as if heaped up.

The next reference to the appendix in typhoid fever, if I am not mistaken, is the account of a distinct perforation described in a paper on peritonitis arising from ulceration and perforation of the appendix, by an Italian, CARLO DE VECCHI, in 1848. The case, which is given in a footnote, was related to the writer by another physician, Robecchi, who, when making a postmortem on a sailor, dying unexpectedly on the seventh day of typhoid fever, found a perforation of the appendix near the insertion of the organ into the cæcum ("*che tagliando, . . . il cadavere di un marinajo, morto quasi improvvisamente in settima giornata di febbre tifoidea, trovò un' ulcera perforata nell' appendice in vicinanza della di lei inserzione nel ceco*").

BUHL (*Zeitschr. f. rat. Med.*, 1854, N. F., vol. 4, p. 342) gives an admirable description of three fatal cases of typhoid fever, in each of which there was an ulcerative perforation of the appendix. At the time these occurred, every fourth patient in the hospital had typhoid fever, and in the course of two and a half months, three out of five autopsies made on typhoid victims showed perforation of the appendix. One was in a woman of twenty, dying on the twenty-fourth day of the disease, who, apart from the usual lesions of typhoid, had a general purulent peritonitis, with an appendix completely amputated by a perforating ulcer just above its blind end. The second case was that of a man, also twenty years old, who began to grow worse about the fourteenth day of his illness, and died on the twentieth. The autopsy showed the usual typhoid changes, with general peritonitis, and an ulcerative perforation of the appendix near its tip. The chief difference between these two cases lay in the fact that in the first, abscesses were found in the upper lobes of the left lung, which was otherwise anæmic. One death resulted simply from the peritonitis

occasioned by perforation of the appendix, while in the other case there was pyæmia, apparently originating earlier than the peritonitis by which death was hastened. BUHL remarks that a pyæmic process originating in the appendix may follow one of two channels: either lodging in the lungs, as in the case just described, or entering the portal system and travelling to the liver. He then describes a portal pyæmia originating in the vermiform appendix, after protective adhesions had insured the patient against the dangers of a fatal peritonitis. His third case is that of a young man, nineteen years old, who died twenty-six days after the beginning of his illness. His symptoms were icterus, a liver enlarged to twice its natural size, stools colored with bile (without, however, any bile in the urine), recurring chills, and pain in the region of the liver. The autopsy showed an empyema of the appendix, which contained a fecal concretion, and had a perforated extremity associated with an abscess the size of a hazelnut, walled off from the peritoneum. A sinus led between the layers of the mesentery to the portal vein, while the adjacent veins were filled with infectious purulent débris (*jauche*). The portal branches of the liver were filled with pus and there were large parenchymatous abscesses. BUHL calls particular attention to this case on account of the rarity of suppurative pylephlebitis. Although he includes it among the three typhoid cases, he says nothing of the condition of Peyer's patches.

Three years later a case of perforation of the appendix in typhoid fever was reported in the United States by SANDS, who presented the specimen to the New York Pathological Society (*Amer. Med. Month.*, 1857, vol. 7, p. 231). The patient, a man twenty-two years old, was overcome by exhaustion and fainted while occupied in his profession as an artist. He recovered in a short time, however, sufficiently to resume his work for some hours, and ate his dinner, soon after which he was seized with severe pain in the right iliac region, with great prostration and vomiting. There was tenderness in the right iliac fossa, greatly increased by pressure, while other parts of the abdomen were free from pain. He also had headache, constipation, and great nervous prostration. The next day he was worse, and a diagnosis of a sloughing appendix was made. The pain in the abdomen became general, although it continued to be worst on the right side. Death occurred on the fourth day. At the autopsy the appendix was found fastened to the back of the cæcum by adhesions. It was distended by a fecal concretion, in which were found a number of strawberry seeds and solid particles. The mucosa was the seat of sloughing ulceration, with a perforation near the extremity, permitting the escape of fecal matter, and causing the acute peritonitis of which the patient died. The solitary and agminated glands of the small intestine were diseased, "having the appearance which they often present in typhoid fever."

Dr. T. R. WRIGHT of Augusta, Georgia (*personal communication*, 1906), had a case of typhoid fever in a young man, in which perforation occurred on the fourth day and operation was performed within eighteen hours, more for the pain occasioned by localized peritonitis. The tip of the ap-

pendix was found covering a perforation about one-eighth of an inch in diameter, closing the opening almost completely and preventing the escape of fæces. There was no pus. The appendix was removed and the opening sewed up. Dr. WRIGHT believes that if the operation had not been done the appendix would have cured the complication.

FREQUENCY.—ROLLESTON (*Lancet*, May 29, 1898) says that out of 60 cases of enteric fever examined at St. George's Hospital, the appendix was found to be altered in 14. In 5 of this number it was simply swollen, in 7 ulcerated, and in 2 perforated. Perforation had occurred in 11 per cent. out of the entire 60 (including those in the appendix).

NACKE (cited by Perrone, *Rev. de chir.*, 1905, vol. 32, p. 729) found 15 cases of perforation of the appendix among 133 instances of perforation of the intestine due to enteritis, verified by autopsy. Other statistics are as follows:

	Cases of Typhoid Fever with Perforation.	Perforation Situated in the Appendix.
HESCHL (reported by Wagner, <i>Schmidt's Jahrbuch.</i> , 1853, vol. 80, p. 42).....	56	8
MORIN (<i>Thèse de Paris</i> , 1867).....	64	12
CHURCH (<i>Records of St. Bartholomew's Hospital</i> , 1881, vol. 17, p. 97).....	21	3
FITZ (<i>Bost. Med. and Surg. Jour.</i> , 1891, vol. 25, p. 346).....	67	5
CUSHING (<i>Records Johns Hopkins Hospital</i> , 1899-1900).....	20	2

Etiology.—Appendicitis may appear during typhoid fever under the following conditions:

1. The appendicitis may be purely accidental, that is to say, appendicitis and typhoid fever, both of which are common maladies, may by accident be found concurrently in the same individual; or a latent or chronic inflammation of the appendix may be roused into activity by typhoid fever.

2. An appendicitis, of a mild or of a severe type, may arise from a typhoid affection of the lymph glands or from an ulcer situated in the appendix, and may even go on to perforation.

3. Appendicitis may follow typhoid fever, appearing within such a brief time after the subsidence of the fever as strongly to suggest a causal relationship.

APPENDICITIS OCCURRING COINCIDENTALLY WITH TYPHOID FEVER, OR ROUSED INTO ACTIVITY BY IT.—PERRONE (*loc. cit.*, p. 731) reports three most interesting cases of acute appendicitis occurring during the course of an attack of typhoid fever. In each case the appendicitis was proved by operation and microscopic examination of the organ when removed. In the first case there was a concretion on the appendix, and microscopic examination revealed a follicular inflammation of mucous membrane. The bacteria present were the *bacillus proteus*, the *streptococcus*, and the *bacillus fragilis*. There were no typhoid characteristics. The second case showed a reddened inflamed appendix of normal length, in which were found the colon

bacillus, the streptococcus, the bacillus fragilis, and the bacillus perfringens. It showed a dull follicular inflammation of the mucosa similar to that in the first case. In the third case the appendix was 12 cm. long, thickened, congested, erect, and free in the peritoneal cavity. Surrounding it was free liquid. The colon bacillus and the streptococcus were found in the obliterated cavity, and the mucosa showed follicular hypertrophy of a high grade, the enlargement of the appendix being due to this cause. Characteristic inflammatory lesions of the lymphatic follicles were also present, with hemorrhage. Nothing in the findings of the case, as in the others, suggested a typhoid origin. In the first case there was a history of previous attacks of appendicitis, and in the second it appeared from the progress of the case that a subacute affection had been stimulated into an acute inflammation. A latent or chronic appendicitis may be aroused into activity during the course of typhoid fever in several different ways, in the first of which the query which suggests itself is: If the patient has a small collection of pus in the appendix, will the accession of typhoid fever suffice to bring on an acute attack of appendicitis?

If the appendix is acutely flexed, or is crossed by bands of adhesions, will the swelling incident to a typhoid affection of the glandular tissue serve to produce an attack of appendicitis? I know of no data with which to answer this question. It is, however, an important one, for the discomfort occasioned by any deviation from the normal in the appendix is apt to arouse the suspicion of disease in the patient's mind, and should an attack of typhoid fever occur, it may be mistaken in its initial stages for appendicitis, because both patient and physician are preoccupied with that idea. In two instances within my own knowledge, physicians who had themselves suffered for more than a year with repeated attacks of pain in the right iliac fossa, were seized with typhoid fever, accompanied in each case with acute distress in the right inguinal region, and were convinced that a severe complication requiring operation had arisen. In one case operation disclosed the appendix surrounded by adhesions and partially obliterated, but not acutely inflamed; in the other, in which the appendix was flexed, there was nothing more than the changes so often observed in it in connection with typhoid fever; in neither case would the operation have been performed could the surgeon have known beforehand the condition of the organ.

If there is a foreign body within the appendix, will its action as an irritant upon the swollen mucosa serve to bring about an acute inflammation? I have found but four cases in which a foreign body is noted to have been present in typhoid appendicitis, and one of these really supervened at the end of the fourth week, when the temperature had been almost normal for two days.

TRUE TYPHOID APPENDICITIS.—The character of the lesions of true typhoid appendicitis has already been shown in the section on pathology (see Chap. VII), where we have seen that the appendix may participate in all the changes to which the agminated glands are liable. The first suggestion of this possibility appears to have been in the discussion following the report of SANDS' case (*loc. cit.*). After reading his paper, he inquired of the Society whether any other than accidental relationship might be supposed to exist between the disease in the appendix and that in the intestines; and if so, which should be regarded as antecedent. The greater intensity of disease in the appendix favored the idea that it had proceeded from below upward; it might be, however, that in the present case the concretion would have remained harmless had not an additional source of irritation been furnished by the extension of disease which had begun in the small intestine. HARRIS said that his experience tended to confirm the latter view, he having in several instances noticed ulceration of the follicles of the appendix coincident with ulceration of Peyer's plates in typhoid fever.

The next expression of opinion to this effect, which I find, is that of NORMAN MOORE (*Trans. Path. Soc. Lond.*, 1883, vol. 34), who remarks: "It has sometimes been thought that ulcers in this situation were previous to or independent of the fever, but the fact that in four cases cited there was extensive general ulceration, makes it probable that the ulceration of the vermiform appendix occasionally present in typhoid fever has the same relation to the fever as ulceration of other parts of the large intestine."

O. HOPFENHAUSEN (*Rev. de la Suisse Rom.*, 1899, vol. 19, p. 105) has investigated the condition of the appendix in typhoid fever in thirty autopsies, and found that in every instance the appendix was affected to a greater or less extent, varying from a mere hyperæmia of the mucosa to extensive ulceration.

I have myself investigated the subject by collecting from literature, from hospital records, and from personal communications, 30 cases reported in more or less detail, in which the condition of the appendix during typhoid fever was demonstrated by operation or by autopsy, in most of which there had been symptoms of appendicitis during the course of the typhoid. In 5 cases the microscope gave evidence of typhoid ulcers within the appendix; in 1 there was ulceration without perforation; in 10 perforation; in 1 appendicitis with abscess; in 4 a simple congestion with a perforation situated in the ileum; and in the remaining 7 there were adhesions, flexions, or obliterative changes. In H. CHRISTIAN'S valuable statistics, taken from 119 autopsies in typhoid patients, there were only 19 which showed changes sufficient to command attention.

From all these sources we have convincing proof that true typhoid appendicitis does occur, further supported by the clinical evidence afforded by other cases which have recovered without operation. It is a matter of common observation that early in the course of typhoid fever patients

often complain of marked pain in the right iliac fossa, and this is probably due, in most instances, to involvement of the appendix associated with swelling and tension that there is every reason to believe accompanies the typhoid lesions in the intestine in all cases.

POST-TYPHOID APPENDICITIS.—The fact that a true typhoid appendicitis exists naturally suggests the question: Can the débris of such infection linger in the appendix undischarged, awaiting a favorable opportunity to produce an attack of appendicitis some time after the patient has completely recovered from the typhoid? And, again, can the typhoid ulceration produce such a narrowing of the lumen of the appendix as will serve to obstruct its discharges, and so favor an attack of appendicitis at some future time?

HOPFENHAUSEN (*loc. cit.*) has especially considered the possibility of such a causal relation between typhoid fever and appendicitis, and has collected statistics concerning it from thirteen different sources. Out of 748 cases, there were 36 in which there was a history of previous typhoid, the interval of time between the two diseases being as follows: In 5 cases, from twenty-four to forty years; in 24 cases, from ten to twenty years; in 2 cases, three years; in 1 case, two years; in 1 case, one year; and in 3 cases, from two to six months. But, as she points out, although the condition of the appendix in every case resembled catarrhal appendicitis, it could not be a true catarrh, since the interval of time between the two diseases (in the majority from ten to forty years) forbids the assumption of any connection between them. The attention of clinicians, however, has not as yet been sufficiently directed to this important point, and it may yet be found that typhoid fever victims are more prone than others to appendicitis. I would suggest that a note as to infectious diseases, especially typhoid, should be carefully added to the history of every appendicitis, and further that all patients should be questioned as to any unusual pain in the right iliac fossa in the course of the typhoid. If any frequent causal relationship exist, our hospitals will probably supply the data from ex-typhoid cases discharged from the medical wards and returning at a later date to the surgical service.

The two cases of post-typhoid appendicitis which have come under my own cognizance are cited at length in "The Vermiform Appendix and its Diseases," p. 439.

Diagnosis.—The decision for or against an operation for appendicitis in a patient who has typhoid fever is a matter of the utmost gravity, and the preliminary question of diagnosis therefore becomes one of prime importance. When symptoms of the fever are not yet fully developed, the first question to be settled is: Has the patient appendicitis or has he typhoid fever? In some cases an immediate positive answer is impossible, but where there is strong reason to sus-

pect typhoid fever, and at the same time one or more of the characteristic symptoms of appendicitis are lacking, it is well to give the patient the benefit of the doubt and to defer decision while keeping him under close observation by both physician and surgeon. A case of appendicitis clearly demanding immediate interference ought to present the syndrome of pain, tenderness, muscular rigidity, and fever. RICHARDSON (*Bost. Med. and Surg. Jour.*, Jan., 1902) says: "Let any of these symptoms be absent, and doubt as to the existence of an acute appendicitis arises. A peritonitis localized about the appendix is at once excluded, though it is more than likely that there is some appendicular lesion. So with pain and rigidity in the right iliac fossa, the absence of tenderness would at once rouse serious doubts as to the existence of appendicitis. Pain, rigidity, and tenderness without fever would be the least doubtful combination, for absence of fever is sometimes conspicuous in really serious local infections of the peritoneum. When typhoid fever is suspected, one or more unusual combinations of the four symptoms just mentioned will prevail. The accurate observer cannot but be on his guard. For example, let there be pain and tenderness in the right iliac fossa, with fever, but without rigidity. The surgeon must account for the absence of rigidity before he opens the abdomen. He must inquire into a previous malaise. He must inquire most minutely into the history of the pain itself, its manner of onset, its relations with temperature and pus, its early and late situation. He must inquire about the prevalence of typhoid in the community. Every abdominal and thoracic organ must be carefully examined. He must, furthermore, make exhaustive examinations of the blood. All this care is imperative in the absence of a single symptom—rigidity of the abdominal muscles. Another example: Assume that in a questionable case of acute abdominal disease there has been no pain, but there is tenderness, rigidity, and fever. The absence of painful onset and of present pain at once suggests something out of the common. A temperature of 104° to 105° F., with gradually appearing tenderness and rigidity, is so unusual in appendicitis that that disease can almost certainly be ruled out, owing to the absence of pain alone. Tenderness and rigidity must be accounted for by other lesions. Indeed, it is so hard to imagine a disease in which, without pain at one time or another, there should be fever, local tenderness, and rigidity, that one can almost say that the combination of these three symptoms alone—fever, tenderness, and rigidity—is an impossible one in acute abdominal disease."

The Widal reaction, which is so valuable in the diagnosis of typhoid fever, unfortunately often fails to develop before the seventh to the tenth day, and in some instances its development is as late as the fourth, fifth, or even the sixth week. It should always be tried, however, as the patient may have a latent typhoid. The value of the agglutinative test is so great that it will determine the diagnosis when present. The absence of this sign in early cases, however, must not influence a decision.

The leucocyte count is a most valuable aid in making a differential diagnosis in cases where doubt rests between an acute appendicitis and a typhoid fever simply beginning its protracted course, with a temporary focusing of the symptoms in the right iliac fossa. The leucocytes in typhoid fever are always low, probably reaching their highest point, eight to ten thousand, in epidemic cases, in the first three or four days of the disease. The count never mounts up, but tends to descend rapidly. BOLAND has shown that the subcutaneous injection of typhoid toxins produces a decrease of the leucocytes. In such metastatic affections as pleurisy, and pneumonia due to typhoid organisms it is also the rule for the leucocyte count to remain low. In typhoid fever the mononuclear leucocytes, especially the large ones, are increased, while the rule in inflammatory disease is for the polymorphonuclear leucocytes to increase. But although the leucocyte count is a valuable aid to diagnosis, it may prove woefully misleading in exceptional instances, when the rule that typhoid fever inhibits leucocytosis fails to hold. In a case where the patient had a leucocytosis of 10,000, which rose in 3 days to 18,000; the diagnosis of appendicitis was then made and operation performed, but no serious disease was discovered. In another case there was a leucocytosis of 17,000, and on operation a typhoid ulcer was found in the appendix without perforation.

CURSCHMANN ("*Der Unterleibstypus*," Wien, 1898, p. 177) states that in typhoid fever a common evidence of the disturbance of the digestion of albumen is found in the presence of moderate or even large amounts of indican in the urine. There is no particular relationship, however, between the occurrence of the indican and the intensity of the infection, and its presence has, therefore, no special diagnostic or prognostic value; indeed, in light cases, particularly those associated with diarrhoea or obstinate constipation, the indican reaction is often more marked than in the severer forms of the disease: when a general peritonitis supervenes, or such a localized peritonitis as occurs in the limited forms of appendicitis (*perityphlitis typhosa*), the excretion of indican is not particularly marked.

It occasionally happens that a localized peritonitis without perforation exists around a typhoid ulcer, giving rise to sufficient adhesions and inflammatory products to form a tumor which may simulate appendicitis. On the other hand, protective and adhesive peritonitis localized in the neighborhood of the appendix occasionally follows perforation of a typhoid ulcer with tumor formation, which also simulates appendicitis. Such a case was reported by H. L. ELSNER (*N. Y. Med. Jour.*, April 9, 1893), in which there was perforation of a typhoid ulcer followed by adhesive and protective peritonitis, and, finally, tumor formation, with symptoms simulating appendicitis so closely that a differential diagnosis was made with great difficulty. The patient finally died of intestinal hemorrhage, and autopsy showed that a coil of the ileum, beginning about 5 inches from the ileocaecal valve, had folded itself against the bend of the colon

laterally, and was firmly held there by inflammatory products. There was no evidence of escape of intestinal contents. A perforation of a typhoid ulcer 2 cm. in length was found in the portion of the ileum resting directly against the colon. So perfectly was the perforation sealed that no gas escaped during the autopsy until the ileum was lifted from its resting-place against the colon. FITZ says (*Bost. Med. and Surg. Jour.*, Oct. 8, 1901, p. 365): "Most cases of recovery from symptoms of perforation of the bowel in typhoid fever are those in which an attack of appendicitis is closely simulated, while the fatal cases of perforation of the bowel in typhoid fever are, in the great majority of instances, those in which other parts of the bowel than the appendix are the seat of a perforation. Hence the prognosis of apparent perforation in typhoid fever is to be regarded as the more favorable the more closely the symptoms and course resemble those of appendicitis."

The second diagnostic question to be answered is: If the patient has typhoid fever, has he appendicitis also? And if he has appendicitis, what is its grade? The diagnosis of appendicitis must rest upon the characteristic local symptoms of an inflamed appendix, supervening upon the already existing symptoms of typhoid fever. There is reason to suspect an involvement of the appendix in every case where severe pain, distinctly localized tenderness, and muscular rigidity exist in the region of the right iliac fossa. The earlier the stage of the disease in which these symptoms appear, however, the more should the physician be upon his guard in assuming that the complication is grave enough to demand operation. I know of but two cases in which a perforation of the appendix has been noticed as early as the eighth day. Later in the disease, that is to say, in the latter part of the second or third week, the sudden supervention of severe inflammatory symptoms in the right iliac fossa raises, not so much the particular question whether there is an appendicitis or whether the appendix is perforated, as the question of an intestinal perforation in general, whether in the ileum or in the appendix. Under such circumstances the particular location of the perforation is a matter of minor importance.

There seem to be no defined set of symptoms which can be denominated pre-perforative. The physician must always, of course, give the closest attention to any unusual complaints of pain in the right iliac fossa occurring during typhoid. When a perforation occurs, there is apt to be a sudden acute pain accompanied by a fall of temperature. The sudden defervescence is also noted in hemorrhage, but without the pain. Intestinal hemorrhage occurred in four of ten cases of perforation of the appendix several days before perforation took place, the pain coming on with the perforation. The occurrence of a hemorrhage, therefore, must put the physician on his guard in anticipating a possible perforation. In addition to pain and fall of temperature, there are marked evidences of collapse, such as change in the facial expression, a small weak pulse, nausea, abdom-

inal swelling, general tenderness, and signs of gas in the peritoneal cavity, with the disappearance of the liver dulness. Free fluid in the abdominal cavity must not be mistaken for an accumulation of fecal material; they may be distinguished one from another by the fact that the fluid is easily displaced by some change in the position of the patient.

CURSCHMANN has called attention (*loc. cit.*) to a particularly interesting group of cases, occurring more frequently than the profession are aware, in which an inflammation of the peritoneum localized in the right iliac fossa occurs during typhoid fever and which he designates *peri- or paratyphlitis typhosa*. The perforation of the peritoneum is extremely minute, or there may be only an excessive thinning of the intestinal wall without rupture to account for the surrounding peritoneal inflammation. The seat of the affection corresponds to the inflammatory tumors of the appendix. In true typhoid appendicitis the perforation also plays an important rôle. Curschmann has occasionally found deep ulcers with most minute perforations in the cæcum, especially in the neighborhood of the valve, and also on the border-line between the cæcum and colon, which afford an explanation of circumscribed inflammations in the right iliac fossa. This *perityphlitis typhosa* is sometimes found at that stage when peritonitis is most apt to develop, but rather more frequently later in the disease, or even during convalescence. He has himself observed it once on the eighteenth and once on the twenty-first day, at a time when the patient was free from fever.

The local manifestations of such a typhoid perityphlitis are in all respects similar to other inflammatory processes in the right iliac fossa; they appear as painful, more or less extensive, resistant, circumscribed infiltrations which apparently lead to abscess formation more readily than is the case in ordinary appendicitis. In one instance there was a retroperitoneal abscess which was successfully opened in the back. He has also noted some cases in which a period of general malaise, with irregular fever and an enlarged spleen, but without diarrhoea or rose spots, was followed by a perityphlitis which at once established a correct diagnosis. In other cases, where a diagnosis of simple perityphlitis (appendicitis) had been made, the history of a febrile disturbance preceding the perityphlitis for two or three weeks aroused the suspicion of a typhoid perityphlitis, the actual existence of which was proved by the fact that the disease then ran a typical course, or else by the occurrence of a characteristic typhoid relapse.

A neglected appendicitis in which the patient falls into a "typhoid" condition from the absorption of the septic products, must be carefully distinguished from true typhoid appendicitis or perityphlitis. Curschmann recalls one case in which the development of a parotitis during the course of the disease seemed to point to typhoid fever, but the complication proved in the end to have arisen from an abscess in the right iliac fossa.

A number of cases have been reported in which typhoid fever has been mistaken, during its early stages, for an appendicitis; the reverse, namely, to mistake appendicitis for typhoid fever, is a much rarer accident.

Treatment.—In a case of suspected appendicitis with an alternative diagnosis of typhoid fever the wisest course is to wait. The best general rule is not to operate for appendicitis in the early stages of typhoid fever—say, up to about the tenth day—in the absence of exceedingly urgent symptoms; give the patient the benefit of the doubt, wait, and watch closely. The clinical history of the collected cases seems to show that, with the rarest exceptions, there is no more occasion for operating upon a true typhoid appendix than there is for cutting down upon the ileum and excising the affected Peyer's patches.

This rule of delay, except in extreme urgency of symptoms, accords with the established practice of some of our best operators. J. B. MURPHY of Chicago, for example, after operating upon three cases in which the symptoms of appendicitis were pronounced, and finding that the lesions in the appendix revealed by microscopic examination were those of a typical typhoid condition, refused to operate upon the next five in his practice presenting similar symptoms, and in each instance the subsequent course of the disease justified the decision. In a personal communication he says: "It is my opinion that typhoid appendicitis should not be operated upon, unless there is a perforation. All my cases recover, those operated and not operated. At the same time, I feel that operation should not be performed except in special cases."

There prevails in some quarters a strong tendency to operate in typhoid fever as soon as symptoms of appendicitis appear, this course of action being encouraged by the swollen condition of the appendix as found, as well as by the favorable outcome of the operation. The surgeon in such a case congratulates himself that he has obviated a serious complication of the disease at what he considers little or no risk to the patient. This would be the case if the microscopic appearance of the typhoid appendix had the same significance as that of an ordinary inflamed appendix, but experience shows that this is not true. The inference that a swollen typhoid appendix must shortly advance to gangrene or perforation is not warranted by the well-established facts. *Per contra*, when, after a siege of pain in the right iliac fossa, the patient lapses into an ordinary typhoid, with an entire subsidence of the severe local symptoms, the observer must not hastily conclude that he was wrong in suspecting an involvement of the appendix in the first instance. The autopsy records show, as I have said, that the appendix is often much swollen, but that this condition is a frequent accompaniment of the early stages of the disease.

That operation in the early stages of typhoid fever for symptoms suggestive of appendicitis may be precipitate is shown by the results in seven of my collected cases, in which the morbid changes connected with the appendix were insufficient to justify the increased risk to the

patient incurred by operation. (See "The Vermiform Appendix and its Diseases," p. 445.)

The following case, occurring recently in the experience of T. S. CULLEN, shows the effect of a sudden strain a week after the temperature had reached normal after typhoid fever.

The patient, a boy, age not stated, was admitted to the Church Home, Baltimore, Oct. 3, 1907. Forty-eight hours before admission, in attempting to strike his sister, he twisted himself in some way and complained of pain in the region of the appendix. He then became very weak, although his temperature was normal and his pulse not much accelerated. When admitted to the hospital, he stated that he had not been able to sleep all night, on account of the excruciating pain just beneath the costal margin on the right side. His temperature was then about 99° and his pulse rather weak and rapid. There was some abdominal distention and a feeling of tenseness in the abdomen, with a leucocytosis of 12,000. An incision was made through the right rectus and turbid liquid found; the incision was then continued upward, until an abscess was encountered, between intestinal loops just below the costal margin. On lengthening it and passing outward, the ruptured appendix was found, with adherent omentum. The appendix was rotten and separated from the base at one point. It was removed, the intestines were carefully wiped, and drainage inserted. On the ninth day the boy was doing well.

The question as to the operation later depends not so much upon the diagnosis of an appendicitis as upon the occurrence of perforation of the bowel, without respect to its anatomical site. The symptoms in order to justify operation must be of a more urgent character than would be necessary in the case of a person in perfect health suddenly affected in a similar manner, as the greater gravity of an operation in the height of typhoid fever warrants the surgeon's assuming greater risks in waiting to make sure that an operation is inevitable. If the classical symptoms of perforation are present, the operator will of course proceed at once without making any attempt to refine his diagnosis as to the exact site of the lesion. It would seem *a priori* probable that the chances of a patient with a perforation of the appendix, disposed as that organ is "in a quiet corner of the abdomen" (H. CUSHING), would be better than with a perforation of the ileum, more centrally situated. The records show, however, that of seven operations in which a perforation was found in the appendix, but one recovered.

The operation, once decided upon, should be performed with promptitude, and minutes, rather than hours, counted precious in making the preparations. If the operator is familiar with the endermic use of cocaine in surgical operations, he will often do better to open the abdomen under a cocaine or a cocaine adrenal solution (see Chap. XVI), than risk the dangers of struggling and the depressing influence of a general anæsthetic.

It is best to make a free incision in the right semilunar line, and evacuate all purulent and fecal material, after which the appendix can be tied off at its base and removed. If necessary, other incisions may be made for more efficient direct drainage. In all such operations the condition of the ileum, if easily accessible, should be noted, in order to ascertain whether it is congested or exhibits diseased Peyer's patches.

The operator should always bear in mind the possibility of a perforation in the ileum as well as in the appendix as found in one of my 30 cases. He should also discover and turn in by sutures any Peyer's patch which seems just about to perforate.

If a perforation which is small in size is found in the ileum, and the surrounding tissues appear healthy enough to hold the sutures, the simplest and best plan is to turn the edges of the opening into the bowel, and close the hole by two or three fine mattress sutures. Where there is a general peritonitis and extravasation of fecal contents, the abdomen should be washed out with a warm saline solution and drained. When there is excessive tympany with peritonitis, it is sometimes best to fix a loop of bowel in the wound, and open it soon after, giving free vent to the gases.

Patients under these circumstances will rarely stand much surgery, and if a more extensive operation is required to effect a closure, if the tissues around the wound are necrotic, or if there is much gaseous distention and peritoneal inflammation, the best plan of treatment is that which will save life, irrespective of the sequelæ. A method practised by R. H. FOLLIS of the Johns Hopkins Hospital, which bids fair to be of great value in the most serious cases, is that of draining the bowel by stitching the opening to the incision, and letting the fecal discharges take place outside until recovery, when the bowel may be resected or anastomosed. This plan of treatment has also been advocated by BLAND SUTTON, and has the approval as well of E. W. GOODALL (*Lancet*, May 21, 1898, p. 1402).

After extensive operations of this character, with protracted drainage, the abdominal wall is left very thin at the site of the scar, and a hernia is almost sure to occur after the patient has been on his feet and has taken active exercise for some time.

In case of operation for typhoid perforation of the ileum, it would be of service if surgeons would always note carefully the condition of the appendix whenever it can be done with safety.

CHAPTER XIV.

APPENDICITIS IN CHILDHOOD AND OLD AGE.

APPENDICITIS IN THE CHILD.

History.—The earliest recorded case of appendicitis in the child is probably that reported by PARKINSON in 1812, in a boy five years old (see Chap. I). ILIFF, in 1832, published the case of a boy, twelve years old, who died of an abscess in the right iliac fossa, and at the autopsy the appendix was found to contain a "stone" (*Lond. Med. and Chir. Jour.*, 1832, vol. 1, p. 214). BÖHR in 1837 (*Med. Zeit. f. Heilk.*, 1837) and BURNE in 1839 (*Med. and Chir. Trans.*, 1839, vol. 13, p. 33) both reported cases in which perforations of the appendix occurred in children of ten and fourteen years old respectively. In 1870, BETZ published a paper entitled "*Ileus in a child seven months old, resulting from perforation of the appendix and agglutination of the intestines*," which is the first occasion on which appendicitis in the child receives separate attention, as the earlier reports all treat of appendicitis *per se*, and mention its occurrence in the child only incidentally (*Memorabil. Heilkund.*, 1870, vol. 15, p. 118). A number of other cases are given in the very complete bibliography preceding G. K. MATTERSTOCK'S admirable treatise in GERHARDT'S *Handbuch der Kinderkrankheiten*, published at Tübingen in 1880, which forms the basis of all subsequent work in this line. In 1897 a paper of the highest merit by F. KAREWSKI appeared in the *Deutsche medicinische Wochenschr.*, followed in 1901 by an admirable article by F. SELTER in the *Arch. f. Kinderheilk.** To these important papers, together with other scattered articles touching upon particular phases of the subject, such as that of V. GIBNEY in 1891 on the diagnosis between coxitis and appendicitis, and that of J. P. C. GRIFFITH in 1903 on the differential diagnosis between appendicitis and pneumonia in the early stages, I am indebted for many of the facts here presented. GRIFFITH'S article, "Appendicitis in the First Two Years of Life" (*Univ. Penn. Bull.*, 1901, No. 8, p. 300), contains one of the most satisfactory cases of appendicitis in the child as yet reported, on account of the excellent clearness of the autopsy record.

A well-nourished negro boy, three months old, began to suffer from diarrhoea with mucus in the stools; in twenty-four hours the fecal discharge ceased, although some blood was said to have passed, and vomiting with obstipation began. The little patient was admitted to the Children's Hospital in a state of collapse, with a rapid weak pulse, sunken eyes, and an abdomen so distended that palpation was unsatisfactory. There were no stools and no straining. Under the impression that an intestinal obstruction might be

* An article on appendicitis in the child was read by A. McCOSH at the meeting of the American Medical Association in Atlantic City, June 7 to 11, 1904, and appears in the *Jour. Amer. Med. Assoc.*, Sept. 24, 1904.

present, large enemata were administered, but only a small quantity of mucus stained with reddish fecal matter was returned. The temperature ranged from 102° F. to 105.5° F. Death occurred five days after the onset of the illness, and the autopsy showed a general peritonitis caused by a gangrenous appendix 6 cm. long. Its proximal portion was healthy and comparatively immovable, while the distal half, which was without a mesentery, was freely movable. About the middle of the organ, separating the sound from the diseased portion, there was a constriction, characterized microscopically by a large increase of connective tissue and the abrupt disappearance of the mucosa, presenting evidence of a chronic inflammation, associated with the presence of newly organized blood-vessels. A little beyond the constriction, and at the beginning of the gangrenous area, the appendix was crossed by a band of lymph, evidently of recent formation and not tightly adherent to it, which stretched from the mesentery of the ileum to the peritoneal coat of the bowel. The end of the appendix was blackish in color, and within it there was tremendous congestion, extravasation of blood, and a complete degeneration of the epithelial cells with a granular detritus remaining to show the former localization of the tubules. It seems probable that this condition was caused by a kinking of the appendix occasioned by the shortness of its mesentery and by the fixation of its proximal half, associated with free movability of its distal end. No concretions nor other foreign bodies were present.

Anatomy.—In the chapter on anatomy (Chap. II) it was shown that the appendix develops by a process of narrowing down of the embryonic cæcal pouch; and the section on "Differentiation" shows that, while primary differentiation between the cæcum and the appendix takes place at the eight-weeks stage (*intra-uterine*), the secondary differentiation occurs at birth. It manifests itself in a dilatation of the proximal pouch, giving rise to the formation of cæcal sacculations. The appendix, owing to this cæcal enlargement, now appears relatively narrow and lies coiled up in the iliac fossa beneath the cæcum, while, as the lumbar region is relatively shorter in the child, the cæcum lies at a comparatively higher level. Moreover, the iliac fossa is less capacious in the infant than in the adult, so that the entire ileocæcal apparatus appears at a somewhat higher level than McBurney's point.

The permanent position of the appendix in relation to the ileocæcal apparatus is determined previous to birth, the only subsequent change being a slight sagging out of the anterior pouch or pouches of the cæcum to fill the growing iliac fossa. This explains the more retrocæcal position of the appendix in the adult as compared with the child. The usual fusion of the mesocolon and the attachment of the mesappendix to the posterior wall take place long before birth, and at this time the position, direction, amount of fixation, and degree of mobility of the appendix have all been determined and undergo no further change. Abnormal positions of the entire ileocæcal region due to arrested development are not infrequent in children, but as these malformations persist into adult life, and are not a special characteristic of the infantile type, they cannot be specially considered here.

As for the appendix itself, the differences between the infantile type and the adult form lie in the relative size of the appendix, the thickness of the coats, and the form of the cæco-appendical junction. Compared with the adult form, the infantile appendix is slightly larger in relation to the size of the body, and considerably larger if it is considered in relation to the entire alimentary canal (see Chap. II, sections on "Differ-

entiation" and "Dimensions"). The coats of the infantile appendix are much more delicate in proportion, especially the submucous coat; the cæco-appendical junction is occasionally funnel-shaped, especially if the cæcum and the appendix are in direct linear continuity. It is stated that the funnel-shaped entrance facilitates the entrance of foreign bodies, but it is probable that it renders expulsion equally easy (see Fig. 97). The valves of the infantile appendix, if present, do not seem to close the mouth of the organ as readily as do those of the adult. The reason for this lies in the relatively greater lumen and smoother mucosa of the infantile appendix, as compared with the narrower lumen and corrugated mucosa at the appendico-cæcal junction in the adult.

Age and Frequency.—Determination of the earliest age at which appendicitis has been known to occur in the child has been a matter of frequent investigation, as well as the relative frequency of its occurrence in the child as compared with the adult. Among the most valuable contributions to this phase of the subject are a thesis by Miss GORDON (*L'appendicite chez l'enfant, Thèse de Paris, 1896*); an article by P. SELTER, already mentioned (*Die Perityphlitis des Kindes, Arch. Kinderheilk., 1901, vol. 31, p. 59*); and another by T. H. MANLEY (*Jour. Amer. Med. Assoc., June, 1901*). Miss GORDON shows that for a period of twelve years antedating 1883, 26 cases of appendicitis were found among nearly 50,000 sick children, while during a period of three years between 1893 and 1896, 80 cases were collected, although the number of children was decidedly smaller. SELTER, reckoning from Mat-terstock's statistics, and allowing at the same time for the relative frequency of children and young adults in the hospital wards, found that appendicitis was seven times more frequent before the age of fifteen than it was from fifteen to thirty. He makes the same computation from Sonnenburg's statistics. A. BROCA (*Brit. Jour. Child. Dis., 1906, vol. 3, p. 231*) considers appendicitis extremely rare in new-born infants. His youngest case was a year and eight months old. KIRMISSON and GUIMBALLOT, on the other hand (*Rev. de chir., Paris, 1906, vol. 34, p. 441*), think that appendicitis is not uncommon in the first two years of life. Their youngest case was eleven months old.

It would seem that diffuse peritonitis is especially frequent with appendicitis in children. SPRENGEL (*loc. cit.*) found it in 46.8 per cent. of 50 cases of appendicitis in children. This is to be expected because of the great frequency of perforation in children.

GRIFFITH, in his admirable essay already mentioned, treating of appendicitis in children of two years old and under, gives fifteen cases within



FIG. 97.—FUNNEL-SHAPED ORIFICE (a) IN A CASE OF ACUTE PERFORATING APPENDICITIS IN A GIRL THREE AND ONE-HALF YEARS OF AGE. (From the Surgical Department, Johns Hopkins Hospital, Oct. 31, 1903.)

Note the large opening in the gangrenous appendix choked by a fecal concretion (J. M. T. Finney.)

that limit. The earliest case at the time he wrote was six weeks; since then, however, a case has been reported by A. GLONIGER of Lebanon, Pa., in which a male child was delivered in a normal labor by J. HARRIS of Jonestown, who was about to ligate the cord when he noticed an enlargement at its base, in which, upon viewing it by transmitted light, a coil of intestine could be distinctly seen. Twelve hours later the case was seen by Gloniger, who found the tumor increased in size; and as other means of relief proved ineffectual, he operated the next morning under ether anesthesia, when the baby was only forty-one hours old. The sac was opened throughout its entire length, and the greater part of the small intestine, with the cæcum, and the transverse colon were found within it. The appendix, which was about an inch in length, stood up straight and stiff, and showed unmistakable signs of inflammation. The intestines were firmly adherent to the sac and were liberated with difficulty. Upon enlarging the umbilical ring, the relief from strangulation was at once apparent by the restoration of the normal color. The appendix, which had no mesentery, was excised, and the wound thus made closed with a suture of fine catgut. The hernial sac was cut away and the peritoneum closed with catgut. The umbilical vessels were then ligated and some troublesome oozing from the skin was controlled by coapting the skin surfaces by means of Thiery's clamps. The child made an excellent recovery.

Prognosis.—Among over a thousand cases of appendicitis collected by GUTTSTARDT in 1906 in Prussia, the mortality in the first to the fifteenth year was 14 to 16 per cent., from the fifteenth to the thirtieth year 6 to 7 per cent., from the thirtieth to the sixtieth year 10 to 12 per cent., and over the sixtieth year 20 to 25 per cent.

Heubner (cited by W. Neuberg, *Deutsche Ztschr. f. Chir.*, 1907, vol. 89, p. 374) had 15.6 per cent. mortality among 35 cases of appendicitis in children, three of them being operative cases. Sprengel and Karewski had a mortality of over 30 per cent. Neuberg thinks the mortality following operations about 23.4 per cent. RIEDEL (*Munch. med. Wochenschr.*, Nov. 26, 1907, No. 48, p. 2367) gives the statistics of the mortality in his clinic in Jena from 1881 to September, 1907. Of the 310 children operated upon during this time 51 died, or 16.4 per cent. Riedel points out that the mortality following operation on adults had been reduced during the 21 months preceding September, 1907, to 2.9 per cent., but that the death rate among children during the same time was 13 per cent. He considers that this relatively poor showing is due to disinclination on the part of parents to subject their children to operation, to the difficulty of making a diagnosis, to the greater seriousness from an anatomico-pathological point of view in the child, and to the fact that very little children are especially susceptible to infection from the appendix.

Etiology.—The causes operating to produce appendicitis in a child are much the same as those acting in adults. The reason why infancy and early childhood are comparatively exempt lies in the fact that the hard fecal concretions so often met with in appendicitis take some

time to form, and are, therefore, rarely found during the first years of life; an additional reason is that an infant spends most of its life lying down; and, furthermore, trauma, which is the most frequent exciting cause in older children (see Chap. IX), is practically absent during infancy.

The great liability of the male sex to disease of the appendix is as conspicuous in childhood as in later life. According to MANLEY's statistics, the proportion of boys to girls is as two-thirds; according to other observers, it is as follows:

	Males.	Females.
Jalaguier.....	112	70
Matterstock.....	21	51
Jacob.....	21	8

Errors in diet are frequently noted in the histories of children, especially in the recurrent form. The relationship between appendicitis and infectious diseases has been fully dwelt upon (see Chap. IX). It must always be remembered that in children the acute exanthemata may be ushered in by misleading symptoms of appendicitis.

Foreign bodies and concretions are met with in children from five years old and upward about as frequently as in adults. J. F. ERDMANN (*New York Med. Rec.*, 1907, vol. 71, p. 759) found foreign bodies in 41 of the one hundred children with appendicitis operated upon by him. Ten of these cases were of pin-worms. It is a matter of surprise, however, to find a foreign body present in a little child, and even in an infant but a few weeks old. In BETZ's case already mentioned, a child seven months old had a perforated appendix covered with a diphtheritic exudate, inside which were three fecal concretions as large as hempseeds, yellowish-white in color, easily broken, and showing the usual concentric arrangement. In another case originally reported by Demme, and cited by FENGER in the *Cyclopædia for Children's Diseases*, a child of seven weeks, fed entirely upon porridge since it was a week old, was taken ill at the beginning of its seventh week with high fever, tympanites and tenderness in the cæcal region, followed by peritonitis and death. The autopsy revealed a diffuse peritonitis, and an appendix dilated and filled with firm concretions, which the microscope showed were nothing more than conglomerate masses of undigested porridge; there was no perforation of the appendix.

A catarrhal condition of the intestine is often an etiological factor in appendicitis in children, as pointed out by GRIFFITH (*personal communication*). According to Sonnenburg's statistics, simple catarrhal appendicitis occurs seventeen hundred times as often in the child as in the adult.

As shown by BROCA (*loc. cit.*), it takes time for appendicitis to develop after the occurrence of gastro-enteritis; therefore appendicitis follows only the chronic cases of catarrh of the bowel.

M. L. GUINON and M. J. COMBY (*Bull. et mém. Soc. des hôp. de Paris*, 1906, p. 805) call attention to the frequency of mucous-membranous enterocolitis as a precursor of appendicitis in children. COMBY

points out that the so-called follicular enteritis is an affair of the lymphoid tissue, and that the disease is easily transmissible to the lymphatic tissue of the appendix, which is a part of the colon. GUINON had 28 cases of appendicitis in children, 23 of which had preceding enteritis. Infection of the nasopharynx, as originally shown by DELACOUR, is often a forerunner of the enterocolitis. This has been the experience of both of these observers, and they assign a causal relationship to the nasopharyngeal disease.

There is undoubtedly an etiologic relation between intestinal worms and some forms of appendicitis. METCHNIKOFF (*Semaine méd.*, 1901, No. 11) and GENSER (*Wien. med. Wochenschr.*, 1901, No. 9) have called attention to the frequency with which *ascarides* have been found under varying conditions. I have myself known several such instances. In one, a woman operated upon in my clinic, a segment of a tapeworm was found.

In several instances children with symptoms of appendicitis have been entirely relieved by *santonin*. ARBORÉ-RALLY (*Arch. de méd. des enfants*, 1900) relates such a case in a boy, ten years old, suffering with excessive constipation; two surgeons made a diagnosis of general peritonitis, but on account of his bad general condition did not operate. On the fifth day of his illness he vomited a living *ascaris*; three days later, after the administration of *santonin*, a second worm 25 cm. long was passed, and after large evacuations he recovered. METCHNIKOFF cites three cases showing distinct symptoms of appendicitis in which the patients, one of them a child twelve years old, were relieved by anthelmintic treatment, without operation. In each instance the eggs of both *ascaris* and *trichocephalus* were found in the stools. He justly lays stress upon the necessity for a microscopic examination of the stools for ova in all cases in which there is any room for suspicion, a measure especially important in children, in whom a slight intra-abdominal source of irritation may provoke violent symptoms with fever. The rôle of the worms may be to produce an erosion of the mucosa, and so open the way for the invasion of bacteria; it may be that an inoculation takes place with the act of exciting the lesions. The *trichocephalus* found in the cæcum produces lesions by its habit of boring inward and imbedding the anterior end of the body beneath the mucosa.

STILL (*Brit. Med. Jour.*, April 15, 1899) looks upon the *oxyuris vermicularis* (pin-worm) as the cause of catarrhal troubles in the appendix. MORY (*Semaine méd.*, 1901, Nos. 11-14) found *oxyuris* in three out of five cases recently under his care. He insists that an immediate examination of the appendix after removal is necessary to discover the worms. A case of this kind which occurred in the practice of my colleague, J. C. BLOODGOOD, has been already cited.

The activity of children in running about and playing especially exposes them to *trauma* in the blows, falls, and violent exertion which are the familiar, hourly events of childhood. The effort, for example, of skipping rope backward many times in succession has been reported

as causing a rapidly fatal appendicitis with perforation of the appendix, which contained a concretion.

Several observers have commented upon a supposed connection between appendicitis and the uric acid diathesis in children. SUTHERLAND in an article on this subject (*Brit. Med. Jour.*, 1892, vol. 1, p. 856) bases his theory on the anatomic similarity between the appendix and the tonsils, which are so often affected in gout, both organs being largely composed of adenoid tissue, a theory first brought forward by BLAND-SUTTON, who also lays stress upon the pathologic resemblance between simple and suppurative appendicitis and the analogous condition of the tonsils.

Symptomatology and Diagnosis.—The differences which appear in appendicitis in the child and the adult assume the utmost importance upon the clinical side. There is a general consensus of opinion that the symptoms in childhood are often extremely vague, and lack the pointed precision of the adult form, which so frequently forces the diagnosis even upon the lay mind.

The abdomen of a little child is but a miniature of the adult in the relative nearness of all the organs to each other and in the close contiguity of those in the pelvis and those in the upper abdomen. *Pari passu* with age and the assumption of the adult form, the organs are separated by a wider interval, their differentiation being thus facilitated. In addition to the difficulties presented by the early age and the approximation of the boundaries of the abdomen to each other, the surgeon has to contend with the incapacity for fixed attention, the lack of appreciation as to the significance of questions and vagueness of expression in answering them, and finally with impatience under examination, especially when the examination is painful. As it is often impossible to elicit a clear statement as to the exact seat of pain, the surgeon must depend largely upon palpation, watching the face of the child during the process. In examining an ill-trained child, or one under the age of ten years, the services of a specialist skilled in children's diseases are of the utmost value, as he, from force of habit and long experience, will better understand the child nature and more readily elicit a response; he is also better fitted to estimate the value of symptoms under circumstances which would only confuse an ordinary observer. While there are these disadvantages, there is, fortunately, the counter-advantage that an anæsthetic (chloroform) is easily administered in children, affording a good opportunity to examine the iliac region through the thin relaxed abdominal wall. Moreover, in children it is not necessary to exclude a number of diseases of the gall-bladder, kidneys, and the pelvic organs, and therefore differential diagnosis is simpler than in the adult.

An examination by the rectum should never be neglected, since the adult finger reaches higher in the infantile pelvis than in that of the adult, therefore the suspected area is more easily touched. KAREWSKI and SELTER have shown that in almost every case in which the disease has advanced beyond the appendix, the exten-

sion takes place along the right pelvic wall, where the inflammatory masses can be easily felt. In 28 cases of appendicitis in children given by Selter, 6 had a general peritonitis and 11 a circumscribed abscess; out of the 11 cases of abscess, suppuration in all but one extended down into the right lesser pelvis, and in 2 of these 10, the abscess had travelled across the rectum and formed a mass on the left side above Poupart's ligament. In one instance it was noted that the abscess lay on the left side and had no connection with the cæcum, but at the operation, when an incision was made in the left groin, a tubular abscess channel the width of two thumbs was found extending down into and across the pelvis, in front of the rectum, and up over the right pelvic wall.

CARRON DE LA CARRIÈRE has put on record 4 cases of recurrent appendicitis in children manifested by vomiting alone, abdominal symptoms and fever being entirely lacking. FRUITNIGHT believes that there is often "in children a prodromal stage, lasting weeks or even months, before conclusive signs are developed by which a diagnosis can be arrived at." (*Arch. of Pediat.*, 1891, vol. 8, p. 937.) Among the premonitory symptoms, he mentions interference with walking and standing, with tingling in the right leg.

No examination of a child with a suspected appendicitis is complete which does not include an investigation of the thoracic viscera; often the first sign of a pneumonia or pleurisy or even of a bronchitis (RICHARDSON) is a right iliac pain, liable to be mistaken for an appendicitis. The least sign of disturbance in another organ in a doubtful case should command the examiner's attention, and such a clue if followed up will in some instances lead to a correct solution of a puzzling problem. It is absolutely necessary that the medical attendant should approach the bedside with calm, undisturbed judgment, forewarned and on his guard against the public attitude of expectation, which is ready at once to count every obscure abdominal pain the sign of an appendicitis and the forerunner of an operation.

KAREWSKI has laid special stress upon the fact that most cases of appendicitis in children are preceded by many attacks of gastro-intestinal disorder, with more or less pain and diarrhoea, or constipation, together with nausea and vomiting. As these attacks often occur in association with an overloaded stomach, attention is almost sure to be directed to the digestion in the early days of illness. BROCA says that frequent vomiting in the morning, rarely bilious in character and without fever, is an important sign of appendicitis in children. Where a child has repeated attacks of colic and intestinal disturbance, especially if any tenderness is found on the right side of the abdomen, appendicitis should be suspected until the contrary is proved. A common preliminary sign is the desire to empty the bladder frequently, associated with pain in doing so. Appendicitis in a child is easily mistaken for a digestive disturbance, from the mild and transient character of the initial symptoms, the discomforts, the abdominal pains, and the constipation. In treating constipation in a child

there should always be positive assurance that there is no appendicitis behind it; in doubtful cases it would be far wiser to treat constipation with opium than with castor oil. In all cases where the diagnosis is not clear, it is wiser to put the child to bed and watch for a few days, than to risk the accidents of an extension while the child is going to school or romping with other children. The stools should be preserved and inspected at frequent intervals. SELTER, in 11,000 cases of children's affections, observed 27 of appendicitis, including some very mild cases. He insists that many cases are lost through a false diagnosis of digestive disturbance such as colic or intestinal catarrh, and cites his personal experience as an example. Up to the age of fourteen, he suffered year after year from attacks of pain in the ileocæcal region, with nausea, quickened pulse, anxiety, and sweatings, associated alternately with diarrhoea or constipation. The diagnosis at the time was "intestinal catarrh" or "typhlitis stercoralis." After he was fourteen he had no more attacks. He insists that in the intestinal catarrh associated with colicky pains, of both nursing children and those of riper years, an unusual tenderness in the region of the cæcum is often revealed by examination, and his conclusion is to the effect that "*colica appendicularis*" is common in children.

The tendency to a larvate form of appendicitis in children, together with the obscurity which may attend it, is well shown by two cases in young girls, patients of E. F. CUSHING of Cleveland, Ohio.

In one the child, going regularly to school, attended as usual on the morning of the day on which Cushing first saw her. She had had no pain nor evident fever, had not been at any time confined to bed and there was no history of previous attacks of colic. The services of a physician were sought simply because she looked white, felt languid, and had no appetite. There was no reason for suspecting any particular organ, but as a routine matter an examination of the entire body was made, when a well-defined mass was discovered in the right iliac fossa. DUDLEY ALLEN operated the next morning, opening an abscess, and removing an appendix which was on the point of perforation. In the second case, a girl seven years old was seen on the second day of an attack of what was supposed by her watchful mother to be indigestion, because of epigastric pain, nausea, and constipation. Her temperature was 100° F., her pulse 80, and her expression bright. Operation on the same day by Allen disclosed an abscess and an appendix near perforation.

While making his abdominal examination the surgeon must bear in mind that the adhesions in a child may be extremely delicate, and more than ordinary care must be exercised in order to avoid any risk of rupturing them. H. GAGE (*Bost. Med. and Surg. Jour.*, May 24, 1894) mentions a case in which the adhesions around a localized abscess in a child were ruptured during sleep, and another in a young adult where rupture took place during an effort at stool. In both instances the disappearance of symptoms was accompanied by collapse, a rapidly progressing general peritonitis, and death. A movable kidney ought not to be mistaken for a diseased appendix from the very fact of its mobility. A congenitally misplaced kidney, however, lying in the right iliac fossa, might easily be so mistaken, if the simple discovery of a mass were taken as decisive.

It must always be remembered that in children, the early symptoms

of appendicitis are apt to be those associated with motion. A. WORCESTER of Waltham, Mass. (*Bost. Med. and Surg. Jour.*, Aug. 4, 1892), relates a case in which a boy, ten years of age, with an indefinite history of three weeks' illness presenting undefined symptoms, was sent at the end of that time to consult a physician; he entered the office with a marked stoop, and a limp so pronounced that he could not stand upright. A diagnosis of appendicitis was made, and on operation a good-sized abscess of the "larvate" form was discovered. Another case of the same kind occurred in the practice of R. D. FREEMAN of South Orange, N. J. While calling professionally upon another member of the family, he noticed a little girl, eleven years old, limping as she played tennis in the yard close by, and standing in a position similar to that of hip disease. On inquiry it was found that she had complained for a few days of indefinite pains in the lower part of the abdomen, and on calling her into the house and examining her, a tender fluctuating mass was found in the right iliac region; the right leg was flexed and adducted, there was muscular rigidity over the lower abdomen, and considerable pain on pressure over and around the mass; the rectal temperature was 103° F. and the pulse 90. She had had no considerable pain at any time and no chill. At the operation, performed at midnight of the same day, a large abscess surrounding the appendix was evacuated and the remains of a sloughing appendix removed.

In several instances it has happened that a pleural empyema has been discovered and operated upon, while the primary cause, a suppurating appendix, has not been discovered until the postmortem. It behooves the operator, therefore, in every case of empyema, particularly in right-sided affections, and above all when the pus is ill-smelling, to bear in mind this possibility, and to make such examinations of the right iliac fossa (rectal above all!) as shall decide this question.

Without doubt, says KAREWSKI, many of the puzzling cases of a puffed-out umbilicus and abscess at this point, followed by fistula, are due to lesions of the appendix. In a few instances the diagnosis has declared itself in the appearance of a small fecal calculus at the umbilicus.

Appendicitis in the child may be mistaken for: Acute indigestion; typhoid fever; ileus; pneumonia or pleurisy; tubercular peritonitis; intussusception; recurrent vomiting; hip disease; hernia; ovarian disease.

ACUTE INDIGESTION.—We have here, it may be, the history of an indiscretion in diet, vomiting, and pain, the latter probably generalized in character without any special localized tenderness in the iliac fossa. There is fever in both cases, but that of the indigestion is more sthenic in character, and there is no progressive increase in the leucocytes as counted from hour to hour; in indigestion the attack is sudden in its onset, with intense pain from the first, associated with much restlessness, and the symptoms disappear quickly with a thorough evacuation of the bowels and a restricted diet.

TYPHOID FEVER.—This disease is slower in its prodromata than appendicitis, creeping up day by day to its crisis, while appendicitis develops much more quickly and with more definitely localized symptoms. I know of no case as yet in which an appendicitis has apparently arisen in the course of typhoid fever in a child to confuse the medical attendant. The profounder and more striking signs of appendicitis will usually prevent any confusion. The Widal reaction becomes the important diagnostic criterion in the later stages.

ILEUS.—Appendicitis in its earlier stages may be mistaken for ileus, beginning, as the latter often does, with obstinate constipation, vomiting, and other evidence of a profound systemic disturbance, without fever, and with a good pulse. In such cases the closest attention must be paid to the local manifestations, and the counting of leucocytes should never be omitted. The worst possible treatment of an appendicitis is the use of enemata to overcome a suspected ileus. KAREWSKI has twice seen cases of diffuse appendicitis which had been treated for five or six days with high injections, and in one instance the castor oil thrown into the rectum was found floating in the peritoneal cavity.

PNEUMONIA AND PLEURISY.—Experienced clinicians have repeatedly noted, especially in children, cases of intrathoracic disease, pneumonia and pleurisy, in which at the outset the pain has been chiefly abdominal. Such being the fact, we cannot be too much on our guard when called to a patient manifestly very ill, with abdominal pain, an elevated temperature, fixation of the diaphragm, constipation, drawn-up knees, and perhaps a swollen abdomen, against too hastily assuming the existence of an appendicitis and the necessity for immediate operation.

J. P. C. GRIFFITH, in an article entitled "*Pneumonia and pleurisy in early life simulating appendicitis*" (*Jour. Amer. Med. Asso.*, Aug. 29, 1903), presents the dangers of an error in diagnosis in a most convincing manner, and I quote one clear case from this source.

"K. S., male, seven years old, admitted to the Children's Hospital November 2, 1899, under the care of H. R. Wharton. He had had at various times more or less abdominal pain, which was never severe until three weeks previously, when he had a typical attack of appendicitis as regarded by the physicians in charge of him. The symptoms at the time consisted of severe pain and tenderness in the right side of the abdomen especially at McBurney's point; fever, constipation, and restlessness. He recovered partially but the tenderness is said to have remained. On October 30th, three days before admission, he had had a recurrence of pain, and again on November 1st. There had been no vomiting at any time. Fever was said to have persisted since the attack three weeks before. On admission the temperature was 103° F., the respiration varying from 32 to 80, and the pulse from 132 to 196. The abdomen was distended, tender and somewhat rigid. These symptoms were especially marked on the right side. There was also bronchial respiration over the entire lower lobe of the left lung. The attending physician had in person taken the child to the hospital in order to have an operation for appendicitis performed. On refusal by the surgeon to do this, he became very angry, disputed the diagnosis of pneumonia, said he had brought the child for the sake of operation solely, and would remove him if it was not performed, and used other language more forceful than polite. He was requested to go to the ward to examine the patient himself again. This he did—and then, apologized. By the evening of the same day the temperature had fallen to 99.2° F. No further abdominal symptoms were recorded, and the pneumonic consolidation rapidly disappeared."

Out of 8 cases given by GRIFFITH, it is noticeable that, while severe abdominal pain, tenderness, and distention were prominent in all, cough was so slight as to attract the attention of only the most watchful eye. A little girl, eight years old, had such intense abdominal pain and tenderness that the resident physician feared arsenic poisoning. Another child, four years old, had obstinate abdominal pain, tenderness in the right iliac fossa and distention, so that the physician who first saw the case made the diagnosis of appendicitis, but the child was admitted to the medical wards because operation was forbidden by the parents. When first seen by Dr. Griffith, "except for a few coarse râles, nothing could be detected on examining the lungs in front. Owing to the great distress of the child, and because the diagnosis of appendicitis seemed so positive, the posterior part of the chest was not examined on this date. On the next day pneumonic consolidation of the left lung was easily found. The abdominal symptoms remained unchanged." On the following day all the abdominal symptoms had disappeared, and the crisis occurred two days later.

J. L. MORSE of Boston has given us a picture of such cases, so complete and clear that nothing is wanting (*Ann. Gyn. and Ped.*, 1900, vol. 13, p. 143), and he warns us that "the abdomen has been twice opened in children by well-known Boston surgeons for appendicitis, when the trouble was lobar pneumonia." His first case presents a typical picture of the shifting character of the signs of pneumonia, from the first abdominal symptoms to the final unmistakable thoracic one.

The little patient, who was seven years old and in perfect health, was struck in the abdomen, during recess at school, by one of his playmates. Shortly afterwards he became faint and nauseated, and was sent home by his teacher. He continued to vomit for twenty-four hours, and on the day following the injury he complained of headache, nausea, and pain in the abdomen, the bowels not having moved. There had been no cough nor sore throat, and the temperature and pulse were but moderately elevated, with no special disturbance of respiration. There was a little abdominal tenderness and slight distention, but a routine examination of the lungs proved negative. On the second day the bowels continued closed, in spite of calomel and salts; there was considerable abdominal distention and increased tenderness, more marked in the right iliac fossa, where there was slight dullness; but no tumor. The temperature was now high, and the pulse and respiration rapid, but, although there was a constant hacking and evidently painful cough, examination of the lungs was again negative, so that the trouble, which seemed abdominal, was considered as probably appendicitis, and as the increased respiration and cough appeared secondary to the abdominal disturbance, but little attention was paid to them. More salts were ordered and the abdomen was poulticed! During the third night there were four movements of the bowels, after which the abdominal distention diminished, and there was very little tenderness, but the cough became more troublesome, and the child complained of pain in the right lower chest and the umbilicus, the respiration being now 65 and painful. An examination of the lungs now showed marked dullness, with bronchial respirations and a few high-pitched râles over the right lower lobe. The diagnosis of lobar pneumonia with reflex abdominal symptoms was then made. The next day the abdominal distention was nearly gone, and during the succeeding twenty-four hours even the slight tenderness disappeared.

MORSE remarks that "cases of pneumonia in children beginning with symptoms pointing to the abdomen, while not common, are nevertheless not very unusual. The predominance of the abdominal symptoms may, however, lead to serious errors in diagnosis. . . . These cases are

probably most often overlooked because the possibility of their occurrence is not borne in mind and the examination of the chest is neglected. As shown by the cases detailed above, however, the physical signs of pneumonia may not be recognizable for several days. Yet even in the absence of physical signs the combination of symptoms is usually such as to justify a probable diagnosis of pneumonia. An acute onset with high temperature is always suggestive of pneumonia. If in addition to the acute onset and high temperature the rapidity of the respiration is increased out of proportion to that of the pulse, the combination is almost pathognomonic of pneumonia. This is true even in the absence of cough. Too much importance can hardly be attached to this combination of temperature, pulse, and respiration, in diagnosis, and many errors may be avoided by keeping it constantly in mind. When it is present, vomiting, abdominal pain, constipation, and even distention and tenderness, may usually be regarded as symptoms of secondary importance, probably reflex in origin."

It is evident from a consideration of these, as well as of other important cases, that, as RICHARDSON says, "in acute right-sided diseases of the thorax, the symptoms of appendicitis may be so easily simulated that a surgeon may be completely deceived."

The differential diagnosis must depend upon attention to the following factors, commonly present in intrathoracic disease: (1) A sudden rise of temperature and persistent high temperature, without, as a rule, corresponding increase in the pulse-rate. (2) Full and sthenic character of the pulse. (3) Disappearance of the fixation of the abdominal muscles with each respiration. (4) Superficial character of the tenderness, which is probably due to a neuritis affecting one of the lower intercostal nerves. It disappears under firm pressure with the whole hand. (5) Rapidity of the respiration, which should always excite attention, and call for closer attention to the chest. In addition, great caution should be displayed in regard to the following points: Close attention should be given to any cough. Examination for thoracic disease should be made in every case of suspected appendicitis in a child. In cases of reasonable doubt it is better to wait and watch for more definite local symptoms either in the chest or in the abdomen before assuming the responsibility of operating. Fewer lives I think will be sacrificed by such a policy than by a hasty interference instituted because there is a possibility of disease in the appendix.

TUBERCULAR PERITONITIS.—In the absence of any other known focus of tuberculosis, an attack of acute tuberculosis accompanied by pain, together with some swelling and resistance localized in the right iliac fossa and associated with marked fever, may present insuperable diagnostic difficulties until the disease has progressed into the chronic stage.

KAREWSKI has reported an interesting case of tubercular peritonitis originating in the appendix. (See "The Vermiform Appendix and its Diseases," p. 463.)

M. H. RICHARDSON, speaking from his own experience, says: "A tumor at the ileocæcal valve was in one case supposed to be appendicular. It proved to be an acute tuberculosis of the mesenteric glands of the mesocolon. A dissection carried thoroughly as far as the receptaculum chyli was permanently curative." (*Bost. Med. and Surg. Jour.*, July 14, 1898.) J. C. P. GRIFFITH (*personal communication*) has had two cases of tuberculosis of the mesenteric glands that were operated on for appendicitis.

MANLEY in speaking of such cases says: "It is quite impossible to affirm whether or not the appendix is involved. Under these circumstances, I have often seen an operation undertaken for appendicitis reveal no lesion of the organ" (*loc. cit.*).

In making a differential diagnosis between tubercular appendicitis and appendicitis arising from other causes, it must be borne in mind that tubercular appendicitis tends to run a protracted course, and the patient seems more tolerant of an accumulation in the iliac fossa than he would be with abscess due to any other cause. There is often an ileopsoas contraction accompanied by a tendency to limp, and emaciation increases as the disease progresses. The history of the parents and also of the locality and the house in which the patient lives, are of importance; the early history of the child itself must also be investigated, especially as to the former presence of enlarged glands, or of cheesy troubles in or near the joints. Finally, whenever a case of appendicitis runs an obscure course, tuberculosis should be suspected.

INTUSSUSCEPTION. — Intussusception of the vermiform appendix is a rare affection, limited, as a rule, to childhood; I have found but one case occurring in an adult, and that was in a woman forty years of age. I have collected and analyzed 19 cases of this condition in children (see "The Vermiform Appendix and its Diseases"), and I find that the average is four years and eight months, the oldest on my list being nine years, and the youngest thirteen months. In regard to sex, there were 11 males and 7 females, the sex in one not being stated.

These cases of intussusception may be divided into three groups:

1. Those in which the vermiform appendix is simply carried along with the intussusception in an incidental manner; that is to say, in which the appendix is compelled to travel with the intussuscepted colon simply because it is organically connected with it.

2. Those in which the base of the appendix itself forms the apex of the intussusceptum; cases in which the intussusceptum starts at this point of the colon.

3. Those in which there is an inversion of the appendix, partial or complete, with or without inversion of the cæcum, colon, or ileum.

The clinical picture of such an ailment is that of a chronic affection characterized by abdominal pain, sudden severe attacks of colic, doubling the child over, and a diarrhoea with blood and mucus in the stools. After such an attack, the child may show improvement, play, and go to school, until there is a recurrence. There is usually, however, a gradual loss of

health and some emaciation. I have found but one case in which the temperature was elevated; and the pulse was not quickened in the intervals. An extraordinary case in which pain was the one symptom is that of McKIDD (*Edin. Med. Jour.*, 1859, vol. 11, p. 763).

In examining the abdomen there is no marked tympany or localized tenderness. A peculiar, elongate tumor, sometimes sausage-shaped, occasionally more or less globular is found most frequently in the left flank, but sometimes in the region of the transverse colon or in the neighborhood of the umbilicus. In several instances a second swelling has been noted. Such a tumor, when carefully examined and its position and dimensions noted, is apt at a later examination to appear different in size and position. It is often extremely movable upon manipulation owing to a long mesocæcum. A case in which two intussusceptions were found in the same patient is given by W. H. WATERHOUSE (*Trans. Path. Soc. Lond.*, 1898, vol. 49).

If the intussusception is extensive, the bowel may be seen protruding at the anal orifice. A rectal examination should never be omitted, as the soft polyp-like mass may be found just within the anus, or within reach of the finger. Examination in these little patients is greatly facilitated by giving enough chloroform to produce complete relaxation.

A remarkable instance, similar to that of McKIDD just cited, in which no tumor could be detected, was a patient of T. A. MCGRAW (*Brit. Med. Jour.*, 1897, vol. 2, p. 956).

The etiology will vary with the starting-point of the inversion. A predisposing factor is a long mesocæcum. Any inflammatory process in the head of the cæcum causing a localized thickening of its walls, or an inflammatory condition around the orifice of the appendix, causing it to pout out into the lumen of the cæcum, would offer a convenient grip for the circular muscles of the bowel to catch and exercise propulsive force in the direction of the current. A tumor at or near the base of the appendix, if there were a loose mesocæcum, would seem to offer a most favorable opportunity for the inversion of the cæcum with the appendix, but no case of this kind has yet been reported.

It is not so difficult to understand how an inflammatory process involving the proximal portion of the appendix might cause at first a swelling and then a pouting of its mucosa into the cæcum, when the swollen oedematous tissue with its strangulated veins would serve to draw the remainder of the mucosa onward, step by step, until the entire organ was inverted.

When the appendix becomes more or less inverted into the cæcum, it may then act as a polypoid tumor within the bowel and give rise to further invagination.

A case has been reported by CONNOR in which a blow on the abdomen is supposed to have given rise to the invagination (*Lancet*, 1903, vol. 2, p. 600).

The title of Mr. Connor's paper is "*Intussusception of the vermiform appendix*," but from the description of the case and the accompanying

diagram, it appeared to me to be one of complete *inversion* of the appendix. On referring the matter to him, he writes me as follows: "The appendix was completely intussuscepted in the true sense of the word. By this I mean that the appendix was completely thrust into the cæcum, 'inverted' on itself like the finger of a glove; thus, when excised, the relative positions of the peritoneal and mucous coats were reversed. The contiguous part of the cæcum was slightly pulled in, forming a dimpling at the basal attachment of the appendix. This evidently was the first step, and was followed by a large intussusception, with the tip of the inverted appendix as the summit of the intussusceptum; the cæcum and ileum being in turn drawn into the ascending and transverse colon. The diagram in my article exactly reproduces the condition found, when all but the appendix itself was reduced. The part excised is now in the St. Bartholomew's Museum."

HAESLER (*Archiv f. klin. Chir.*, 1902, vol. 36, p. 817, Case 9) cites a case which shows several stages of invagination quite clearly.

In one of my collected cases a probable appendicitis is cited as the supposed cause of the intussusception, but it is certain that if the appendix had been previously inflamed, its walls thickened, or bound down, an inversion could not occur. The third edition of J. B. Deaver's book on "Appendicitis" contains a good illustration of a case of intussusception of the appendix into the colon (Plate XIX).

If the colon enters the intussusciens, the appendix of course goes with it. The invagination of the appendix with the colon may then be inferred in all such cases. The inversion of the appendix, more or less complete, may be suspected when the invagination is reduced down to a small hard tumor in the right iliac fossa. On the other hand, an appendicitis in a child has been mistaken for an intussusception. GRIFFITH gives two such cases in his series of 15 occurring in children of two years and under.

Treatment of Intussusception.—It occasionally happens that nature herself will effect a cure by a spontaneous amputation of the appendix. An excellent illustration of this is shown in a case reported by J. McFARLAND (*Proc. Path. Soc. Phila.*, 1902, vol. 4, p. 163).

The following plans of treatment may be employed, preferably in the order given:

Palliative, by means of manipulation, massage, enemata, etc.

Cœliotomy and reduction, by manipulation, with removal of the appendix.

Cœliotomy and reduction, by opening the cæcum, and effecting reduction by counter-pressure from within, followed by removal of the appendix.

Amputation of the appendix and of the adjacent chronically inflamed cæcum.

Amputation of the entire cæcum.

Amputation of the cæcum and ileum.

Amputation of cæcum, ileum, and colon, as far as involved.

The first attempts at treatment will naturally be palliative and directed toward ileocolic intussusception in general. Warm enemata of flaxseed tea may be given, with the pelvis elevated, and an attempt may be made under chloroform to reduce the tumor. The patient should then be well bandaged and kept on a restricted diet.

Where there remains a persistent tumor, however small, the intussusception is sure to recur, and the only proper plan of treatment is that of operation by some one of the methods mentioned above. Several cases in my list appeared to do well for a time under palliative treatment, but a recurrence always soon took place, making it necessary to have recourse to surgery. It may be laid down as a rule, therefore, if there is a residual mass, operate. The danger in waiting is that of the obstruction to the circulation, with the peritonitis, and the sloughing which may take place. Before undertaking any form of operative treatment on a child, it is well to remember that a child loses heat more rapidly than an adult, and therefore particular pains should be taken to keep the little patient warm before, during, and after an operation.

The incision may be made over the tumor, or in doubtful cases in the median line, near the umbilicus. The appearances may then at first sight be puzzling, as in the case reported by P. S. HALDANE (*Scot. Med. and Chir. Jour.*, 1903, vol. 12, p. 333). Here the appendix was simply invaginated from root to tip and enclosed in the sheath of the cæcum.

If we would divide these invaginations in which the appendix forms the apex of the contained bowel into groups, we might classify them as follows:

1. Those in which there is a partial invagination.
2. Those in which there is a complete invagination of the whole organ, as in the case last cited.
3. Those in which there is an invagination of the appendix with the cæcum, advancing a varying distance into the colon.

The simplest operative procedure, and that most suitable when the appendix alone is the peccant organ, is coeliotomy and reduction by manipulation. The intussuscepted bowel is inverted, squeezing it gently from above, while exercising traction from below, so as to bring the entire appendix into view, when it may be amputated and removed.

If the bowel just above the cæcum is soft and pliable, it may be invaginated into the cæcum, and used in this way to make counter-pressure on the appendix, while attempting its re-inversion. Unfortunately, the thickening of the surrounding parts is frequently such that the method of reduction by manipulation often cannot be accomplished without great risk of rupturing the cæcum, a thing which actually happened in Waterhouse's case.

The method of opening the cæcum and reducing the appendix by pressure from within is described in a case published by G. A. WRIGHT and K. RENSHAW (*Brit. Med. Jour.*, 1897, vol. 1, p. 1470).

In cases where the inverted appendix is the only portion of the intussusception which cannot be reduced, it is best, after opening the cæcum, to amputate the appendix, a plan pursued successfully by PITTS (*Lancet*, 1897, vol. 1, p. 1602).

When the appendix is completely inverted, it seems hardly necessary to make the colic incision, as was done here. If the mesappendix can be tied off, it ought then to be sufficient to ligate and divide its vessels and sew up the little pit at the inverted base, as is done by Edebohls in his ordinary operation for removal of the appendix by inversion, after which the appendix sloughs off within the bowel and passes out by the rectum. Such a plan has the advantage of avoiding the very serious risk of exposing the wound to the often foul cæcum accumulations, as occurred in a case reported by A. R. KNIGHT (*New Zealand Med. Jour.*, 1890-91, vol. 4, p. 106).

In cases of old intussusceptions, in which the appendix, together with a portion of the cæcum, is either invaginated or inverted, the chronic inflammatory alterations, which are characterized by great thickening, rigidity, and œdema of all the tissues involved, as well as by numerous adhesions, are often so marked that any persistent or forcible attempts at reduction become fraught with the utmost risk of serious injury to the bowel or even its complete rupture. The rule may, therefore, be laid down that gentle efforts only are warranted in attempting to effect a reduction. In chronic irreducible intussusceptions a more radical plan of treatment must be adopted. Excision of the appendix with the adjacent portion of the cæcum should be the rule here, as illustrated in the case of MCGRAW, already cited, in which he cut through the cæcum at the neck of the intussusception, just where the infolding occurred, removing the invaginated portion, and leaving behind at least an inch or more of the cæcal wall extending from the cut edge to the ileocæcal orifice. This opening he united by a double row of catgut sutures, and covered the wound with the omentum.

Amputation of the entire cæcum with the appendix has been successfully practised by D. ACKERMANN (*Beitr. f. klin. Chir.*, 1902, vol. 37, p. 580).

The plan of resecting the entire caecum, with a portion of the ileum as well, has been successfully employed by D. B. LEES (*Lancet*, 1898, vol. 1, p. 1400).

In cases where the diseased process has progressed so far as to involve the colon as well as the ileum, it becomes necessary to employ the last method on our list: amputation of the caecum, with both ileum and colon as far as they are involved. The following case, reported by G. J. WESTERMANN, is the only one I have met with in which such extensive measures were necessary (*Weekblad van det Neederlandsch Tijdschrift von Geneskunde*, No. 24; see also abstract in *Beitr. f. klin. Chir.*, 1903, vol. 37, p. 585):

A little girl, six years old, had a chronic intussusception, and on operation the greater part of the ascending colon (15 cm.), the cæcum, and a long piece of ileum (20 cm.) were removed. The vermiform appendix, which was 6 cm. long, and the thickness of an index-finger, was found inverted (*umgestulpt*) into the cæcum.

In all cases the amputation should be done in the healthy tissues of the bowel, above the inflamed thickened portion. The resected and sutured bowel ought then to be brought down to the wound, and an iodoform gauze drain inserted. This is better, I think, than covering the bowel with omentum. If the operation demands haste, one of Murphy's buttons is the best expedient.

RECURRENT VOMITING. — J. P. C. GRIFFITH (*personal communication*) has called attention to the differentiation of recurrent vomiting from appendicitis. He had a case which was attributed by one of the foremost surgeons to appendicitis, and the appendix was removed. Later the vomiting recurred, and in the end proved fatal, in spite of the absence of the appendix. The disease can be confounded only with exacerbations of a chronic appendicitis, in which vomiting is the principal symptom. Recurrent vomiting most often simulates acute intestinal obstruction.

HIP DISEASE. — V. P. GIBNEY, in 1881, first called attention to the danger of mistaking chronic appendicitis for hip disease, and the article he then published under the title "*Perityphlitis in children, illustrating points in the differential diagnosis of hip disease*" (*Amer. Jour. Med. Sci.*, 1881, N. S., vol. 81, p. 119), still remains the best contribution to this branch of the subject, although the confusion has been made a matter of comment by more than one writer. It will be a sufficient warning to the unwary to state that an error in diagnosis between these two conditions has been committed by surgeons of excellent reputation, and therefore coxitis must always be considered as a possibility in uncertain cases.

In GIBNEY's original article he cites 6 cases occurring within his personal experience.

One of the six (the fourth), a boy six years old, was carried into the office of the Massachusetts General Hospital, because he was unable to walk, and gave the following history: He had been in perfect health and sound of limb until three weeks before, when he had a fall. During the following night he began to have pain in the right hip; the next day he could scarcely walk; and four or five days later, when seen by a surgeon of distinction, he was pronounced suffering from hip disease, a weight and pulley being applied as appropriate treatment! During the next three weeks the patient suffered much pain in the right knee and groin, severe enough to require anodynes at night. His rectal temperature on admission to the hospital was 101° F.; he was much emaciated; his tongue was heavily coated; and he was unable to stand without bearing his whole weight upon the left limb, while keeping the right semiflexed at the hip, with the knee rotated inward; walking was entirely out of the question. Sitting on the side of the bed, he voluntarily crossed the right leg over the left knee; lying prone, nothing abnormal was seen, except a deviation of the lumbar spine to the left; lying on the back, he voluntarily flexed the thigh on the pelvis completely. He could both abduct and adduct the limb, but he could not extend it beyond 90 degrees without pain, and, if passive extension was tried, he resisted and cried. Rotation could be easily made if carefully executed; pressure over the trochanter in the line of the neck as well as concussion gave no pain. There was no infiltration about the trochanter, nor below Poupart's ligament. The abdominal walls were a little retracted, and there was no tenderness nor infiltration in either ileocostal space nor in the left fossa,

but in the right tumefaction could be distinctly felt within a triangular area bounded above by a line extending from top of the crest of the ilium to the median line just below the navel. There was dulness and excessive tenderness, but no well-defined tumor. A diagnosis of perityphlitis was made, and the case treated by rest in bed, laxatives, vesication, and poultices or hot fomentations. Under these measures the symptoms gradually subsided, and in less than four weeks after the child entered the hospital, he was completely cured. The functions of the hip were perfect, and when seen again, three months later, he was as well as ever.

GIBNEY's remaining cases, while not so striking as this one, demonstrate plainly that such an error in diagnosis is easily made during childhood. Another case of the same kind is given by H. MYNTER ("Appendicitis," p. 479).

Such an error in diagnosis as these cases illustrate will be avoided by the physician who sits down carefully at the bedside and spends a little time in palpating and compressing the hips, in palpating the lower abdomen, and in slightly rotating and extending the leg, the attention of the child being at the same time diverted. In any case of lingering doubt, an examination should be made under an anæsthetic, and the patient watched from day to day.

I give two cases that have recently occurred at the Johns Hopkins Hospital which illustrate the handling of patients when the diagnosis is in doubt:

1. J. K. A., a boy thirteen years of age, April 1, 1907 (J. H. H., Surg. No. 20519). The patient had been well until seven months before, when he fell and struck his back against a tree. A month after there was severe pain in the right sacro-iliac region, extending down the side of the right leg and into the knee. No history of previous attacks of abdominal pain and family history negative. On examination the right leg was found flexed at an angle of 45 degrees and there was great resistance on an attempt at hyperextension; there was pain on pressure over the right sacro-iliac synchondrosis. When the sacro-iliac test was applied there was pain, referred to the right sacro-iliac joint. The patient walked on crutches and would not put all his weight on the foot; he was unable to bend forward. On the supposition that there might be tuberculosis of the sacro-iliac joint, tuberculin was given ($3\frac{1}{2}$ milligrammes), with a negative reaction both locally and generally. Palpation over McBurney's point elicited a slight soreness in this region, and it was decided to operate in order to ascertain whether or not the appendix was involved, or, if not, what caused the psoas contraction. On operation the appendix proved to be in a state of chronic inflammation and the tip was extraperitoneal, lying immediately on the psoas muscle, with quite a number of adhesions about the base. The appendix was removed and the patient made a normal recovery, the pain in the sacro-iliac joint disappearing immediately.

2. Miss E. C., age thirteen, March 20, 1907 (J. H. H., Surg. No. 20556). The patient was brought by her mother, who said she was one-sided. There was no pain in the back nor in the abdomen, but the child was pulled down on the right side,—that is to say, there was a right lateral deviation of the spine without any compensatory curve. She was given exercises to hyperextend and to make the spine more flexible. In a week she returned, saying that exercise increased pain in right side. She was operated on April 7, 1907, and the appendix was removed. A pathological examination report showed acute ulcerative appendicitis with an obliterated tip. She made a perfect recovery, after which her spine straightened of its own accord and the lateral motion elicited no pain.

HERNIA.—Of 56 cases of hernia of the appendix analyzed by RIVET, 13, or 23 per cent., occurred under the age of thirteen. It is naturally more frequent in males than in females, occurring in the proportion of nearly 70 per cent. in the former to 30 in the latter, including all ages,

while the inguinal form is much the commonest (J. H. JOPSON, *Proc. Path. Soc. Phila.*, 1900). These hernias may be divided into two classes: congenital and acquired, congenital hernia being understood as a congenital predisposition which manifests itself, if not at birth, at least soon afterward. It would, perhaps, be more literally correct to use the term "infantile" to designate a hernia occurring in the earliest years of life, and "acquired" for the forms developing later.

G. A. PIERSOL, in a clear, thoughtful article on "*Early infantile hernia of the vermiform appendix*" (*Univ. Penn. Med. Bull.*, Oct., 1901), says:

"The favorable conditions offered by the vaginal process before birth for the engagement of the neighboring parts of the intestine are universally recognized. That such involvement does not more frequently occur is probably due, as stated by Schmidt, to the preponderance of head presentations, the absence of respiratory movements, the inactivity of the abdominal muscles, and the meagre peristalsis of the fetal intestines. Additional evidence of the influence of gravity is shown by the fact that, although 14 per cent. of all inguinal hernias occur during the first year, they usually do not appear until after the third month, or not until the infant is carried in an upright position."

The causes of the descent of the vermiform appendix into the hernial sac (inguinal canal) are: (1) an anatomical attachment connecting the appendix closely with the cord called the *plica vascularis*, analogous to Clado's ligament in the female, extending from the cæcum and appendix to the infundibular pelvic ligament and the ovary; (2) to adhesions of the appendix to the migratory peritoneum adjacent to the cord; (3) to an open inguinal ring with a preternaturally long appendix; (4), what amounts to the same thing, a cæcum with a long mesentery.

In a case described by PIERSOL, of a negro infant about three months old, the cæcum, which was of the typical infantile form, occupied a position considerably lower than usual in the right iliac fossa. The entire length of the appendix lay in a hernial sac, extending a little more than half-way to the bottom of the scrotum. The appendix was 84 mm. in length, or nearly two and a half times longer than the average length at birth, which, as determined by RIBBERT, is 34.1 mm. There was a circumscribed attachment of this appendix to the wall of the sac, as well as a marked thickening of the latter, from which Piersol concluded that the adhesion of the appendix was the result of an early inflammatory process, and not of persistent fetal attachment.

The diagnosis of a hernia of the appendix is possible when the worm-like organ can be palpated within the sac, especially when, after palpation, upon inversion of the child, it slips out of the sac. It is more easily felt when inflamed, thickened, and rigid. A diagnosis will be made more frequently if the displacement is always suspected and felt for.

The sequelæ of such a misplacement may be those of an appendix normally placed, with the added liability to inflammation from trauma, kinking, adhesions, the accumulation of foreign material, or strangulation

at the neck of the sac. An appendix in a hernial sac may become irreducible in consequence of inflammation and adhesions contracted with the surrounding part; or suppuration may be set up in the neighborhood, forming an abscess, opening externally and creating a fecal fistula; or finally, general peritonitis may result.

The operation for this condition may be relatively simple, and it can be performed on the surface of the body, much like an appendicitis operation, so long as it is done early, and the disease remains limited to the extraperitoneal pouch. Neglected cases, however, may be associated with a general peritoneal infection with all its attendant risks.

OVARIAN DISEASE.—Several instances have been reported of a mistake in diagnosis between appendicitis and ovarian disease in the child. PORTER, in 1892, reported the case of a little girl eleven years old, in which the mistake arose from the twisting of the pedicle belonging to a small ovarian cyst. The little patient had had three previous attacks of pain in the region of the right iliac fossa, all of which had come on rather suddenly and disappeared as quickly; one after a warm rectal enema, the others spontaneously. She had never menstruated, nor did she seem to be near puberty. When seen forty-eight hours after the beginning of the attack there was a slight elevation of temperature with pain and exquisite tenderness in the right iliac fossa and a sensitive tumor just above Poupart's ligament. The tenderness and tumor seemed to be rather too far down for the appendix, and the diagnosis of appendicitis was made with some hesitation, disease of the uterine adnexa being considered and excluded. At the operation a vertical incision through the right rectus revealed a right ovarian cyst the size of a small egg, its pedicle being slightly twisted by three complete turns, and showing beginning gangrene. A similar case of twisting of the pedicle is mentioned by FITZ, and VON FABER has reported a case of "*Steatoma of the ovary*" with perforation of the appendix, in a child three years and a half old. Here the symptoms were colicky pain in the abdomen with marked enlargement, and a worm-like swelling in the right iliac fossa. The abdominal enlargement increased until the child could not stand, and was accompanied by œdema of the right foot. Death took place at the end of six months from the beginning of the illness, and at the autopsy the right ovary was found converted into a "steatoma, weighing sixteen and a half pounds, more than half of the body-weight. In the middle of the tumor was a cavity containing serum, and a bluish substance, in size and appearance resembling a pregnant uterus. In the vermiform appendix was a pinworm, which had bored through the tip of the appendix to the tumor." (*Med. Cor.-Bl. d. württemb. ärztl. Verhand.*, 1885, vol. 25, p. 221.)

ACTINOMYCOSIS.—KAREWSKI (*Dtsch. med. Wochen.*, 1897, vol. 33, p. 321) records the following case:

A child had an appendicitis with considerable exudate, but slight general disturbance. On recovery he was sent to the country, when he began to show much peculiarity of gait, in the form of persistent flexion at the hip-joint, which was attributed to weakness. Soon

after his return to the city he became ill again, with more general symptoms of an indefinite description, but nothing characteristic of appendicitis. At last a swelling developed in the right inguinal region, eventually occupying the right lower abdomen, where there was a board-like infiltration arising from an abscess which had broken on the outer side of the thigh, after passing the fossa vasorum, and under Poupart's ligament. There was no fever and no pain; some resistance could be felt through the rectum. When an incision was made, the golden-yellow granulations characteristic of actinomycosis were found. The abscess was traced as far back as the brim of the pelvis and behind the peritoneum; Poupart's ligament was divided, after which the incision was carried over to the bladder and the region of the appendix exposed. The author says that it was clear there was an affection of the appendix, because, after a few days, and with the diminution of the swelling, a tit-like process of the intestine was visible in the wound, from which fecal matter escaped. After some deceptive improvement, an extension of the process between the liver and the bladder was discovered. The case had not terminated when reported.

Treatment.—The treatment of an attack of appendicitis in a child should begin when the disease is in its earliest stages, or even when it is merely suspected. If the child has an attack of acute gastro-intestinal disturbance with vomiting and some pain in the right iliac fossa, or if there is a mild incipient attack of catarrhal appendicitis, it must be kept quiet in bed, on restricted liquid diet, with enough opium to set the bowels at rest, and with an ice-bag applied over the appendix. It is of the utmost importance in these prodromal stages to avoid such active treatment as purgation and enemata, which are calculated to do so much harm in an appendicitis. BROCA (*Bull. et mém. Soc. de chir. de Paris*, 1906, p. 762) insists on the importance of treating muco-membranous colitis by proper dietetic and hygienic measures, not only before an operation for appendicitis, but after it. For, he says truly, although an appendicitis may have been due to a preceding colitis, the removal of the cause does not necessarily remove the disease in the colon, therefore he treats his patients as long as may be necessary to restore them to health.

A patient in bed, while the diagnosis is uncertain, should be closely watched by physician and nurse, and careful note of the symptoms kept from hour to hour. If the physician judges that an operation may be needed, he should have all his plans made in advance to act with the utmost promptitude when the decision is reached.

Every case of frank appendicitis in a child should be operated upon if seen in the early stages of the disease. If seen at a later date, that is to say, from the third or fourth day on, it is best not to operate, if there are decided signs of improvement, as shown by lessened temperature, slower pulse, and such amelioration in the general condition as is evident to a practised eye, but, above all, by a regression in the local symptoms, particularly in the absorption of the exudate.

So many cases of appendicitis in children end in a general peritonitis, and so many (SELTZER estimates about one-half) end in the formation of an abscess, that it should be a rule to give prompt surgical relief as soon as a clear diagnosis is made. So eminent a pediatricist as ROTCH (*Pediatrics*, 1896, p. 888) has declared that "inflammation of the appendix cecum is essentially a surgical disease, and is one which under all circumstances should

be placed immediately in the hands of those who are skilled in abdominal surgery. From my observation of the disease I am so strongly impressed with this fact that I consider an extended description of it in medical lectures, and by physicians, out of place."

SELTER, however, recommends that in every case, even with severe symptoms, a course of expectant treatment should be tried for one or two days, and then if there is no improvement, if the swelling, which is being watched by rectal examinations, is found increasing in size, and if the peritoneal pockets are filling out, he declares there is no time to lose. I feel sure, however, that this is too great conservatism, and will often prove fatal in a long series of cases. If the diagnosis is clear, and if a good surgeon can be had, it is better to operate a few times too often than to regret having occasionally postponed doing so. The rule may therefore be laid down that operation should always be performed when the symptoms are progressive; when there is increase in fever, in pulse-rate, and in the exudate; when vomiting persists; and when tympany is present. If operation has been postponed on account of general improvement, and the exudate, which is being closely watched by careful palpation above as well as through the rectum, does not diminish after five or six days, it is better to operate than to risk septic infection from a concealed focus of suppuration.

If a child has had a number of attacks, the interval operation is to be preferred, on account of its safety; skilled operators estimating the risk of operation at this date as 0 per cent.

When a child has survived an attack of appendicitis, and a mass or a cord remains in the iliac fossa, there is less danger in operating and removing the appendix than in risking a sudden general peritonitis from the rupture of a small abscess left behind in this way.

When an abscess has formed, the incision should be made over the most prominent part at any point between the median line and the anterior superior spine. The incision should always be a large one, and an extensive transverse incision, such as KAREWSKI has made use of in some instances, may sometimes be required. Two incisions, one on the right and one on the left side, are necessary more often in children than in adults; several instances have occurred in children where death was due to an abscess on the left side which had been overlooked. An incision on the left side alone should never be considered sufficient. As a rule, it is best to do as little as possible beyond thoroughly opening and evacuating the abscess and removing the pus. If the abdominal cavity is opened by accident, the utmost care must be taken to prevent the entry of pus, and the opening should at once be plugged with gauze. BROCA has in many cases successfully adopted the plan of opening the abscess and clearing up the suppuration, and then at a later date performing a secondary operation to remove the appendix. It is best to avoid extensive resection above the omentum in large abscess cases. Karewski has often brought out the necrotic or deeply infected omentum, and left it lying on the surface, where, if it is properly protected

and rendered harmless, it may slough off and granulate, or it can be drawn back again into the abdominal cavity.

In every operation it is well to stimulate the patient throughout with small doses of brandy in warm enemata, or small doses of strychnine, from $\frac{1}{80}$ to $\frac{1}{160}$ of a grain hypodermically given two or three times, and above all, to keep up the vitality by avoiding exposure of the surface of the body by operating in a warm room and by keeping the little patient warm on a blanket with hot-water bags beneath. The preparations for the operation should be so carefully made that the moment the child is ready, the operator will be able to begin and advance to a conclusion without delay. The delicate tissues of the abdomen must be handled with extreme care, and adhesions clearly distinguished from bowel before cutting.

If the child is very restless after the operation, and cannot be readily restrained by the nurse, a Bradford frame affords an excellent means of restraining it in a relatively immobile posture for the first few days, while the infected area is being walled off from the peritoneal cavity at large.

Even desperate cases of general peritonitis should be given a chance. There is absolutely no hope, under such conditions, without an operation, and there is always a possibility of recovery with one. KAREWSKI relates a case in which he positively refused to operate, because the child, which was brought to him with a profuse peritonitis, was moribund and pulseless, but the mother begged so piteously for some action that he opened the abdomen in the median line, cleansing it as well as he could, and tamponing the wound without sewing. The child recovered. Other cases of recovery under the most desperate and apparently hopeless conditions are reported. Extensive incision under a cocaine solution is a method which might be favorably employed in cases such as these.

SENILE APPENDICITIS.

Appendicitis occurring after the fiftieth year has certain peculiarities that entitle it to separate consideration. The subject has been most carefully treated by E. MERIEL (*Rev. de gynéc. et de chir. abdom.*, March-April, 1907, p. 329), from whose work the following notes are taken. If the appendix of an old man is compared with the appendix of the adult, it is evident that after the fiftieth year the mucous and lymphoid coats of the appendix undergo slow and progressive atrophy. *Macroscopically*, nothing characteristic is to be noted in the appearance of the senile appendix; there is a long type and a short type, and sometimes the cavity is closed at the distal and proximal portions while the central part remains as a closed cavity. Usually the older the patient the shorter the appendix. According to Barthélémy (*Rev. méd. de l'Est*, 1905, Sept. 15, 1906), the diameter is in inverse proportion to its length. While the appendix of the adult measures at least seven mm. in diameter (according to Testut), at sixty years of age it is three mm. more in diameter, remaining of this size during the remainder of life. Although this short appendix feels hard to the touch (Morris) during this period of life, from sixty to eighty

years, it is only one or two mm. thick as against five mm. in the prime of life (Testut).

Microscopically it is seen that in the appendix of old age the submucous lymphoid tissue becomes less in quantity and atrophies gradually, until between the ages of seventy and eighty it disappears entirely. The cavity is obliterated in whole or in part, either by the involution of old age or by previous inflammatory action. Meriel in his collection of senile appendices has found evidence of inflammation (hyperplasia of the glands and follicles) in only three cases; generally connective tissue has been present as the cause of the obliteration. He considers that a chronic irritation is contemporaneous with involution, or, in other words, that these two things are parts of the same process of involution.

Frequency.—According to Dr. BOVIS (*L'appendicite chez les gens âgés*, 1905, *Semaine méd.*, 1905, May 21, p. 241), who collected statistics from a number of authors, appendicitis occurs after the fiftieth year in the proportion of 5 to 6 in 100. It is seen three times less between seventy and eighty than between sixty and seventy and is rare after eighty.

Etiology.—As bearing upon the occasion of previous attacks of pain in the right iliac fossa in the cases of senile appendicitis, statistics are presented by Rostotzer and Moskowicz showing, that, as a rule, these patients have not suffered with crises of right iliac pain, therefore that this form of appendicitis is spontaneous.

Symptoms.—The onset of appendicitis in the aged is usually insidious. Without tenderness at McBurney's point, without especial rise in temperature, the patient experiences discomfort in the iliac fossa. Induration soon makes its appearance and, later, abscess. Complications such as perinephritic abscess and phlebitis of the thigh are common. The slow and insidious progress makes diagnosis difficult and postpones surgical interference.

Diagnosis.—The diagnosis depends on:

1. Careful observation of the temperature. According to Hertzog half the patients have a temperature under 102° F., and according to Bovis (*loc. cit.*) 55 out of 100 do not have a higher temperature than 102° F.; indeed a moderate degree of fever is characteristic.
2. Slight tenderness over McBurney's point, or entire absence of this sign.
3. Muscular rigidity and continuous hyperæsthesia are present.

On account of the laxity of the abdominal walls in old age, the collections of pus often acquire great size; in fact, the abscesses are apt to be large rather than small.

Hernia of the appendix, crural or inguinal, is more frequent in old age than at other periods of life. Bariéty, Jacquemin, and Barthé-lémy, who have collected statistics, all agree on this point.

CHAPTER XV.

TYPHLITIS.

THERE IS perhaps no subject in the whole realm of medicine in regard to which the views of the profession have undergone such a complete revolution as that of inflammatory affections of the right iliac fossa. The medical historian traces the evolution of knowledge concerning them from decade to decade through the past century with ever-increasing interest, and notes with surprise how often keen and well-trained observers, in possession of facts which should have afforded a right understanding of the nature of these affections, have yet failed to draw the simple conclusion so abundantly warranted by the premises. The records of the subject closely resemble the mortifying history of the search for the cause of malaria, in which a few facts patent to everybody contained the solution of the problem. Where to-day are the affections known as typhlitis, caecitis, stercoral typhlitis, typhlo-enteritis, and their ilk? All these names, so well known of old, have vanished, and in their stead appendicitis appears.

The typhlon, or cæcum, was the organ persistently accused in all right iliac inflammatory diseases for over half a century, whence the still too frequent misnomer "perityphlitis." The first step toward a clear understanding of the truth was the establishment of two sets of diseases in clinical nosology; one being the acute and perforative forms of inflammation, which were attributed to the appendix, the other the slow-forming, indolent swellings, laid to the account of the cæcum. Aggressive surgery next made it plain that the appendix was the cause of the latter affections as well as of the former, and finally, to-day, the question is seriously raised whether the cæcum is ever the seat of primary inflammatory lesions, aside from those occasioned by such special infection as tuberculosis, cancer, typhoid fever, and lues.

The recurrence of symptoms after the removal of an appendix may be due to typhlitis; furthermore the symptoms are often wrongly ascribed to the appendix.

By typhlitis is understood a localized inflammatory affection of the cæcum, beginning in the mucosa and going on, it may be, to ulceration and perforation. It may be acute or chronic. A typhlitis secondary to an appendicitis is not rare, and it may also exist as a part of a dysenteric inflammation of the colic tract or with tuberculosis, cancer, or actinomycosis. Primary typhlitis, however, is a rare disease, although, as pointed out, an inflammation of the appendix resulting in perforating ulcer of the cæcum through continuity of tissue, may be wrongly

interpreted as primary disease of the cæcum. It is likely, however, that disease of the cæcum is often overlooked because the conditions that tend toward the recovery of the cæcum from inflammatory affections are more favorable than those of the appendix. Cases of primary typhlitis are being reported in the literature with ever-increasing frequency. Affections of the cæcum, as NOTHNAGEL says, are identical with those of other portions of the intestinal tract, and if in some instances an inflammation, an ulcer, and a perforation are found in it, it is not because there exists a special predilection for this locality; their occurrence there is merely accidental, and the peculiarities of the case are those imposed by the anatomic relations of the bowel. STRÜMPFEL (*Lehrb.*, 1899) declared that "typhlitis has never been demonstrated anatomically."

In the hope of setting this old but important question at rest, I will adduce such facts as have come to my notice in the literature of the subject.

In the first place, there are three possible conditions to be borne in mind in investigating the relations of inflammatory diseases of the cæcum to those of the appendix.

1. An ulceration of the appendix may involve the caecum either by continuity or by contiguity.

2. An ulcer in the appendix may exist at the same time as an ulcer in the caecum, one being entirely separate from the other.

3. Inflammation or ulceration may exist in the caecum alone.

An inflammation of the cæcum associated with a sloughing appendix and advancing to ulceration and gangrene, is by no means uncommon in neglected cases of appendicitis, or in the fulminating form; so common, indeed, is this direct extension of the disease from the base of the appendix by continuity that it is not worth while to collect cases to prove what forms a part of the experience of every active operator. This group of cases, however, is well worth a separate, careful anatomico-pathologic study.

The involvement of the cæcum, by extension of the sloughing process from some point in the appendix beyond its base to the contiguous cæcum, is only found in cases where the appendix is anatomically disposed close to the side of or behind the cæcum, being often plastered down to it by old inflammation. A case of this kind is given by MISS GORDON ("L'appendicite chez l'enfant," *Thèse de Paris*, 1893).

The practical importance of recognizing this group of cases in which infection proceeds by contiguity lies in the fact that it may be possible for the surgeon to prevent such an occurrence as a post-operative perforation of the cæcum by using extreme care in detaching an adherent appendix from the colon, as well as by suturing carefully the torn muscular coat of the cæcum. In many instances it is better to strip the mucosa out of the external muscular coats of the appendix than to attempt to detach the entire organ.

Ulcer of the appendix coincident with ulcer of the caecum is a rare occurrence, in which the colic affection is probably secondary to that of the appendix, except when it is due to typhoid fever. MISS GORDON (*loc. cit.*) cites a case in which there was an ulcerative affection in the appendix, complicated by an ulcer in the cæcum, the two being anatomically separated.

The third of the possible contingencies—namely, the possibility of inflammation or ulceration of the caecum in the absence of any disease of the appendix—constitutes the real crux of the question. Were we to draw our statistics in regard to it from the older records, the condition would not appear so infrequent; ulceration of the head of the cæcum with perforation was then often noted, but in these statements the appendix is either not mentioned at all, or it is significantly stated that it was involved in the sphacelation; our present knowledge enables us to read plainly between the lines, that in every one of these instances there must have been a gangrenous process originating in the appendix and extending by continuity into the adjacent cæcal wall. MATTERSTOCK (*Handb. d. Kinderkr.*, 1880, vol. 4, Abth. 2, p. 903) says that out of 49 cases of "perityphlitis," one or more perforations of the appendix were found in 37, and in this number he cites 4 cases taken from literature dating from 1853 to 1880, in which it is stated that the cæcum was perforated, but in none of them is the condition of the appendix mentioned. No case can be accepted as one of primary disease of the caecum in which it is not also definitely stated that the appendix was examined and found healthy.

RENVERS, of the Moabit Hospital (quoted by Sonnenburg), says that, leaving out of consideration the more frequent carcinomatous and actinomycotic tumors, as well as tubercular and typhoid ulcers, ulceration may occur on the posterior wall of the cæcum in association with fecal accumulations. Twice he has himself seen pressure necrosis of this kind, once due to a coprolith the size of a pigeon's egg held fast in a cæcal pocket, and once caused by a fecal concretion which formed in the cæcum about a gall-stone the size of a walnut. It may, perhaps, be asserted without fear of contradiction that ulceration of the cæcum never occurs simply as the result of fecal stasis in the cæcum.

Out of 600 operations (*autopsies in vivo*) on patients with symptoms of "typhlitis," SONNENBURG found but a single instance in which the disease was primary in the cæcum, and that was an inflammatory affection of the mucosa (*Perityphlitis*, Leipzig, 1900, p. 10).

An instance of simple, localized, primary typhlitis is given in JORDAN's case (*Archiv f. klin. Chir.*, vol. 1, p. 534), in which there was an exact microscopic examination of the cæcal wall during or soon after the attack in addition to the necessary definite statement as to the normal condition of the appendix.

A girl, ten years old, was taken ill with typhlitis (*Blinddarmenzündung*), with fever and pain; in a short time a growing exudate a hand's breadth in size and painful on pressure appeared in the cæcal wall. The exudate could also be felt through the rectum. The abdomen was not distended or sensitive, the inflammation was localized, and there were no symptoms of any serious general prostration. Although there was some diminution in the induration and the general condition was good, obstipation continued, with pains in the cæcal region when the bowels moved. The diagnosis was made of an acute appendicitis in the stage of diminution, with perhaps an appendix containing pus and imbedded in lymph, and six weeks after the onset an operation was performed. An incision was made above Poupart's ligament, and the cæcum discovered in the midst of inflammatory adhesions of the small intestines. After separating the adhesions, the vermiform appendix was found free, with smooth intact surface. It was removed and proved normal, except for a fecal concretion the size of a pea. After freeing the cæcum, a brawny area of infiltration corresponding to the intestinal adhesions on the anterior wall, and the size of a two-mark (fifty-cent) piece, 0.5 cm. thick, was found and excised. The healthy edges of the wound were then united with silk sutures. The resected area lay below the level of the ileum, and about 0.5 cm. to the outside of the base of the resected appendix. The abdomen was closed with drainage, and a rapid recovery ensued. The piece of cæcal wall removed was 3 by 2 cm. in size, and on its mucous surface there was a superficial ulcer 2.5 cm. in length and 0.5 cm. in maximum breadth; the surrounding mucosa was swollen. Microscopic examination showed no evidences of tuberculosis but an extensive small-celled infiltration, most marked in the mucosa and submucosa. In the infiltration zone, staphylococci were seen. The case, therefore, presented a simple, primary, acute typhlitis without perforation, which in its clinical course as well as in its anatomic details corresponds to the classical picture of a stercoral typhlitis.

The following additional cases have been reported:

1. P. SICH (*Deutsche Ztschr. f. Chir.*, 1903, vol. 70, p. 591). A case of primary acute typhlitis (stercoralis). A woman of fifty-eight was suddenly seized with chills and fever, with pain in the right iliac region. The diagnosis of appendicitis was made. At operation, which took place on the sixth day, the appendix was found perfectly normal. On the anterior inferior wall of the cæcum (which was filled with hard fecal masses) was a spot, the size of a pea, where only the visceral peritoneum separated an ulcer of the cæcum from the peritoneal cavity. This was buried by suturing over it two folds of the bowel wall. Recovery.

2. O. KUKULA (*Sbornik Klinický*, 1906, vol. 8, fasc. 6, and *La polyclinique*, Oct. 1, 1906, p. 289). A case of primary typhlitis in a woman of twenty-seven, who had had several typical attacks of appendicitis. At operation a perforation of the cæcum was found, around which were several superficial ulcers of the mucosa.

3. REISINGER (*Münch. med. Wochenschr.*, 1903, No. 40) found two cases of primary typhlitis among 350 cases of perityphlitis operated upon in the hospital in Mainz.

4. LANG (*Beiträge z. klin. Chir.*, 1903, vol. 38, p. 56). A case of primary typhlitis which began with colicky pains, diarrhoea, fever, and local tenderness on the right iliac fossa. On the third day an ileocæcal tumor was noted. At operation the cæcum was found to be much thickened and inflamed, while the appendix was normal.

5. THOMAS (*Therap. Rev.*, Phil., Oct., 1904; cited by C. A. McWilliams, *Ann. Surg.*, 1907, vol. 45, p. 840). Two cases of primary typhlitis.

6. C. A. MCWILLIAMS (*loc. cit.*). Case of a man, forty-eight years old, upon whom he operated at the Presbyterian Hospital, New York, on September 21, 1906. The chief symptom was vomiting. There was no blood in the matter vomited nor in the stools. Pain of a severe character was situated in the right hypochondriac, right epigastric, and right iliac regions. Diarrhoea alternating with constipation, with fever and prostration, were features of the past history. The temperature was 102.6° F. and the pulse 110; the leucocytosis 16,600. There was tenderness with rigidity in the right iliac region, and a rounded mass the size of a lemon could be felt. A diagnosis was made of acute appendicitis, probably following cæcitis. At operation some serous fluid was found situated about the cæcum, and the appendix, which was one and a half inches long, was found situated retrocæcally and free from adhesions. When removed and cut open, it proved normal, but the cæcum was much thickened. It was resected and the ileum anastomosed with the ascending

colon. The patient died. The pathological examination showed three or four ulcerations, admitting the tip of the finger, and covered with a grayish slough. Microscopic examination revealed acute suppurative inflammation of the intestinal wall, necrosis in places, and general œdema. There was no tuberculosis. Although the appendix showed microscopic indications of active inflammation, it was plain that the process was secondary to the typhlitis.

7. E. A. POLYA (*Deutsche med. Wochenschr.*, June 1, 1905, p. 862). Two cases of undoubted primary typhlitis, occurring at St. Stephen's Hospital in Budapest. In both the diagnosis was chronic recurrent appendicitis. At operation the appendices were found normal by both macroscopic and microscopic examination. In each case there was a small perforation of the cæcum and omentum. In one instance the cæcum was free from evidence of inflammation except at the site of perforation; in the other the walls of the cæcum were much thickened throughout and in places deprived of mucosa. Recovery took place in both cases.

8. FELTY (*Gaz. hebdom. de méd. et de chir.*, Jan. 23, 1902, p. 74. Quoted by McWilliams, *loc. cit.*). Case of a woman forty-four years old, in which a diagnosis was made of chronic enteritis and death following the administration of a laxative. The autopsy showed the cæcum extremely distended and its walls very thin; in one place there was perforation. The appendix was normal in every respect.

From an analysis of the above cases it is evident that a localized inflammatory disease of the cæcum is usually mistaken for disease of the appendix. The symptoms of primary typhlitis are not characteristic. There is no differential sign by which we may distinguish a case in which a pin perforates the cæcum from one in which it perforates the vermiform appendix. A foreign body, such as a large coprolith, might be felt by careful palpation if the abdominal walls were thin; foreign bodies might also be revealed by the X-ray skiagraph.

Celiotomy, in accordance with the indications given in the section on treatment, is the proper procedure, whether the disease is confined to the cæcum or includes the appendix. The appendix should be removed because of the danger of subsequent infection. If, after opening the abdomen, the diagnosis is doubtful, a piece of the cæcal wall should be removed for microscopic examination and the bowel closed by suture. An abscess should be opened and drained; at a later date the bowel may be exposed and liberated, and the fistulous orifice excised and closed. If it fortunately happens, as in McMURTRY's case, to be possible to expose the openings in the bowel in such a way that they can be treated and sutured at once, this is manifestly the best plan, saving a tedious convalescence. Care must be taken in such a case to cut well out into the sound tissues of the bowel beyond all suspicion of disease, looking out for gangrene and undermining of the mucosa. The best treatment of ulcerated areas, threatening to break through the external coat of the intestine, would probably be by infolding the bowel at those points, using one or two layers of sutures. A loose drain should always be left in place for several days, in case the sutures do not hold. In JORDAN's case the ulcer was resected with success.

CHAPTER XVI.

TREATMENT PREVIOUS TO OPERATION.

THE RELATION OF THE GENERAL PRACTITIONER TO APPENDICITIS AND ITS MEDICAL TREATMENT.

BEFORE considering the question of operation, it is important to say a few words upon the medical treatment of appendicitis, — that is, to consider briefly the best measures for relief in cases which do not require operation, as well as those it is advisable to apply in any case until the services of a surgeon can be secured.

In the first place the general practitioner ought to suspect appendicitis in every case of abdominal cramps or colic in whatever part of the abdomen they are situated, and he should constantly keep this suspicion clearly in mind until some other cause is definitely proved to account for the symptoms which have already abated. He ought to bear appendicitis in mind in every apparently acute indigestion associated with nausea and vomiting, as it is a matter of common knowledge that nearly every bad case of appendicitis has been mistaken for an acute indigestion at the outset. The general rule, and the only safe rule in all doubtful diagnoses, especially in cases which may become surgical, is while keeping in mind all the various conditions which might give rise to the symptoms, to let the judgment incline towards the most serious complaint on the list. In this way we give the patient the benefit of the doubt and avoid the too common mistake of proceeding on the diametrically opposite plan, namely that of presuming that the least serious cause is at work. If the physician follow the latter plan, he will then only recognize the most serious case when the trouble is far advanced, and when it may have progressed beyond the possibility of relief at the surgeon's hands. The general practitioner will do well in some cases to withhold all morphine, or to give but little until he has watched the case and determined whether or not there is a tendency for the symptoms to become localized in the right iliac fossa, and whether or not there is any suspicious tenderness there. As he examines the patient, he will do well to divert the attention, so as to get rid of any element of expectation while he palpates the iliac fossæ. It is a good plan to put one hand in each fossa at the same time, and to press alternately on the right or the left to see if there is any difference.

In seeing a case for the first time, the physician will, as a rule, be greatly helped by making a careful inquiry as to previous attacks; he will do well to remember that a history of repeated attacks of severe "indigestion" is commonly associated either with serious trouble in the appendix or with stones in the biliary system. In a doubtful case he may not be able to

make a diagnosis at once or to determine just what organ in the abdomen is at fault, and it may be necessary to give repeated small doses of morphine to relieve the pain. As long, however, as there is any doubt, he ought to see the patient at intervals of a few hours until the doubt is set at rest. If he can get some one to make a leucocyte count, and the leucocytes are found creeping up from eight and ten to twelve or fifteen to twenty thousand, he can in many instances make a prompt diagnosis of an appendicitis in cases which would otherwise have remained doubtful for hours longer.

The practitioner will always be justified in making a diagnosis of appendicitis when, with continued pain and some nausea, the distress settles in the right iliac fossa, where there is some resistance and tenderness; above all, if there is more or less fever with the other symptoms. Appendicitis should also be suspected by him in all those cases where, with more or less vague abdominal pain and without well-defined local symptoms, the patient seems unaccountably ill and is evidently growing worse. He ought to familiarize himself with the anxious expression or the dusky, weary look which goes with the graver forms of peritonitis (appendicitis) where pain and local symptoms are not so marked.

The first step, which is of prime importance in the treatment, is to put the patient to bed and keep him quiet in the dorsal position; the next is a rigorous regulation of diet, medication, and treatment in general, all of which is best carried out by a trained nurse acting under careful surveillance from hour to hour until all danger is past. If the patient is constantly watched by a nurse, and the surgeon makes his visit at first from two to four times a day, any increase in the symptoms denoting an undue extension of the disease will at once be noted, and the surgeon will be in readiness to abandon the medical treatment without a moment's delay, in order to attack the disease by the more direct measures of surgery.

Of equal if not greater importance to general rest of the body at large, is local rest of the alimentary tract, and the first care, after putting the patient to bed, must be the absolute withdrawal of food; a step taken for two reasons, first, to secure that freedom from peristalsis which is only found in an empty intestinal tract, and second, to unload the bowel of such materials as might in case of rupture escape into the peritoneum. As long as there is vomiting, the patient has but little desire for food, and thirst may be satisfied with little sips of iced water, a little cold tea in coffee-spoonful measures, or hot water to rinse the mouth. Sometimes minute quantities of champagne are helpful.

Ice should be applied locally over the right iliac fossa in a rubber bag, spread out thin so as to cover a wide area, and not heavy enough to produce discomfort by its weight. The bag should be separated from the skin by a layer of flannel, and the ice often renewed. D. H. Williams uses menthol dissolved in alcohol locally for the relief of pain. Thin poultices sprinkled with tincture of opium may also be used over the entire abdomen.

The treatment of the bowels constitutes the crux of the subject to-day. Some surgeons are still loud in their praises of the advantages accruing from free purgation, especially with saline cathartics. The opinion of most, however, is largely in favor of keeping the bowels entirely at rest by the use of opium or morphine, in order to check peristalsis, a method strongly advocated by some of the earliest writers on appendicitis.

It is a good plan to begin the administration of opium by giving the patient just enough to relieve pain and afford a little ease, either in the form of morphine hypodermically, or in small doses of opium (one-quarter to one-half a grain) by the mouth. The principle of its use is to "splint" the bowels, and by checking peristalsis to favor the formation of adhesions which wall off the affected area and prevent a general peritonitis. It should be kept up for several days, until all the symptoms have subsided, and a general improvement is noted. The form of its administration may be varied by using the aqueous extract or the tincture in small starch enemata.

After complete subsidence of the symptoms, the bowels may be unloaded by small oil enemata, given at intervals of several hours, or by calomel or castor oil given by the mouth. The use of strong salines for the purpose of emptying the bowels in these cases has so often been associated with disastrous results that it is probably wiser to abandon them altogether. A large enema is also extremely dangerous; cases have been reported in which a considerable portion of one has been subsequently discovered by the surgeon lying among the intestines in the abdominal cavity. The surgeon will sometimes find it of advantage to introduce a well-oiled finger into the rectum, and then, if he finds impacted feces, to soften them and empty the bowel by throwing in a few ounces of sweet oil.

When using opium, it must be constantly borne in mind that large doses have the disadvantage of obscuring the clinical picture and concealing the real condition of the patient. It relieves the pain and sensitiveness only in an artificial way, and the meteorism which it causes obscures palpation. Only enough opium should be given to produce quiescence, the pupils being watched and the urine kept under observation in order to be sure that it is not too much diminished in quantity; the sensorium also must not be too much obtunded. With improvement, both local and general, small quantities of food may be given by the mouth, beginning with albumen and water, a little cold coffee, or tea. Small nutrient enemata may be given even in the midst of the attack, and continued until convalescence.

The practitioner will do well to advise operation as soon as a positive diagnosis of appendicitis is made, unless the case is decidedly improving hour by hour. If there is a persistence in the local symptoms, the patient ought to be operated upon at any stage of the disease whatever. With the careful walling off of the intestines by abundant gauze, there is no danger in opening and evacuating an abscess, even if the peritoneal cavity is opened.

I think the general practitioner who does not often do surgical operations would do better not to operate upon an appendicitis case when a satisfactory surgeon cannot be found, unless there is a well-defined mass in the right iliac fossa with heat and tenderness—evidence of abscess formation. In such a case, if he be so placed that he is the only available operator, the patient may be carefully cleansed with warm water and soap, and the parts surrounded by towels wet in 1-5000 bichloride solution. The practitioner himself can put the patient profoundly asleep, and then entrust the chloroform to an assistant who acts under his continuous observation and direction. He will then make an incision from two to two and a half inches long over the most prominent part of the swelling, rather to the outside towards the anterior superior iliac spine and Poupart's ligament. After dividing the skin and subcutaneous fat, he opens the muscles layer by layer: first the strong fascia of the external oblique, then the internal oblique, after which he may see a few fibres of the transversalis, each layer taking a little different direction. As the deeper layers are reached, the tissues often become œdematous, and it is a good plan either to thrust a hollow needle ahead into the swelling, or, after cutting a little further, to push in a pair of sharp-pointed artery-forceps and open them. This will, as a rule, enter and open the abscess, which should then be widely incised, so as to give the freest possible discharge to the accumulated pus. The best results are secured when the drainage wound is extensively opened from top to bottom. A timid drainage through a little opening will necessitate one or more secondary operations. A big free drain means complete evacuation and rapid healing of the wound. It is well not to attempt to take out the appendix unless it is plainly seen lying in the wound, when it may be tied off and amputated, or clamped and removed, leaving the clamp on for twenty-four hours afterwards, surrounded by the drain. A loose iodoform gauze drain ought to be packed in the wound, which in the course of a few weeks fills up from the bottom and pushes the drain out. Such cases are liable to be followed by hernia, but this is a small price to pay for the saving of life. If the drain is removed after three or four days, it may then be replaced every twenty-four or forty-eight hours, and the wound cleansed out from the bottom with a solution of peroxide of hydrogen in an equal part of water.

When the general practitioner has on hand a case of appendicitis and has sent for a surgeon to meet him in consultation and if need be to operate upon the patient, valuable time can be saved in a critical case by making the necessary preparations for operation before the arrival of the consultant. In the first place, the patient should be kept absolutely quiet in a dark room without mental or bodily disturbance; he should be put on a diet of albumen water, say a teaspoonful to a dessertspoonful of the white of an egg in cold water, with a little lemon juice if he likes, every hour. If the bowels have not been opened, an oil enema consisting of about five ounces of oil with one ounce of glycerin may be given to unload the rectum. If the patient is not too nervous to have it done, the abdomen may be gently

but thoroughly scrubbed with warm water and soap, to cleanse the surface and to remove dry epithelium. After doing this, a towel saturated with a bichloride of mercury solution 1-5000 may be laid on the right lower abdomen, like a poultice, for about two hours before the surgeon's arrival. The room should be prepared for the operation, by clearing out all extra furniture and leaving it as bare as possible; the walls ought to be wiped over with a damp cloth, so as to remove all dust without stirring up any; large clean vessels should be provided for water, a dozen towels boiled and dried, and ten gallons of water put on to boil. If there is much pain, enough morphine should be given to keep the patient quiet.

When the surgeon operates out in the country, the general practitioner often has to assume the charge of the case afterwards, and from his standpoint the post-operative cases of appendicitis may be divided into three classes: the simple, where the wound is closed; those in which an abscess is drained; and those which are drained for a general peritonitis.

In the simple cases the wound needs no care except to protect it from contamination. The bowels may be moved on the fourth or fifth day by giving calomel, say four or five grains, or a substantial dose of cascara sagrada, such as the aromatized fluid extract, one to two teaspoonfuls. When the desire for an evacuation is felt, an enema of warm oil may be given, from six to eight ounces. As soon as the nausea is over, the patient may be given soft food; if all goes well, the wound may be exposed and examined and the dressings changed on the eighth day. If there is any rise of temperature, the practitioner ought to look under the dressings at the wound to see if there is not reddening or undue tenderness, caused by a skin abscess which needs opening. In dressing the wound use sterilized forceps and do not touch it in any way with the fingers. A case which has done well may get up from bed in ten to fourteen days and go to work again in from three to four weeks.

When the wound is drained, the dressings should be changed at least every twenty-four hours, but the wound is best let alone as long as there is a free outflow and the patient does well. If there be discomfort and abdominal disturbance, the flow is checked; then the drain must be pulled out a little, to start the flow afresh. After this, little by little, about two inches at a time, the drain should be delivered until it is all out, when a narrower, smaller drain is inserted. Drainage cases ought to be kept quiet until the wound is all closed, and even then, if they walk about much or work, hernia is pretty sure to follow.

The general peritonitis cases are best treated with the patient seated up in the Fowler posture (see Fig. 98); or half sitting up and lying inclined toward the right side, so as to keep up a free flow in the direction of the opening. In these cases it is best not to give any fluid by mouth for several days. Murphy's method of slowly instilling from four to twelve quarts of normal saline solution into the rectum in twenty-four hours may be used with advantage; a rectal tube or catheter is attached to a fountain syringe which is kept filled with warm saline fluid which escapes drop by drop.

A normal saline solution can be made up extemporaneously by adding a small teaspoonful of common table salt to a pint of warm water. Enough morphine must be given to keep the patient comfortable and the bowels at rest. The convalescence will be much more protracted, and one must rest satisfied if the patient is well after many weeks.

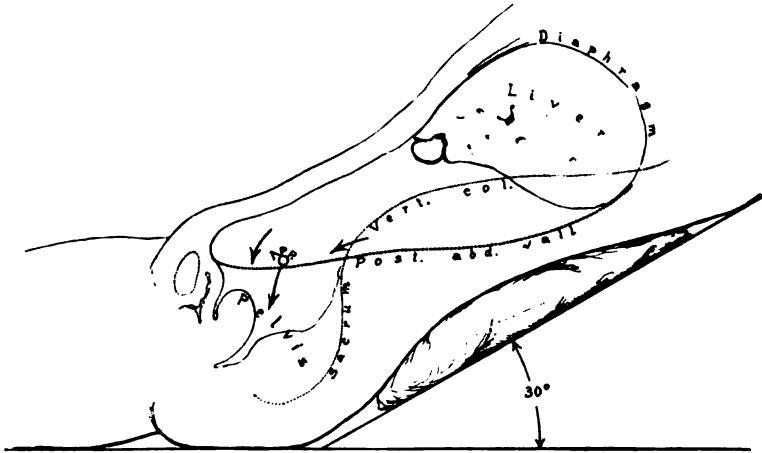


FIG. 98.—FOWLER'S METHOD OF DRAINAGE.

The thorax is elevated to cause the fluids to gravitate into the pelvis instead of upward toward the diaphragm.

In order that the essential points in the diagnosis and treatment of appendicitis as it comes before the general practitioner may be emphasized, I give them here in the form of aphorisms.

APHORISMS IN APPENDICITIS FOR THE GENERAL PRACTITIONER.

1. Appendicitis is the commonest of all acute intra-abdominal conditions.
2. In all cases of severe abdominal pain, withhold morphine until the diagnosis is clear and appendicitis excluded or included.
3. Then give morphine, as the best treatment is to "splint" the bowels.
4. Never give purgatives in appendicitis.
5. The treatment of appendicitis is just the opposite of that of colic from ingestion of irritating substances; it therefore requires great care in differentiating.
6. Appendicitis, as a rule, starts unexpectedly, as for example in the middle of the night, without any apparent reason in indiscretion of diet, etc.
7. Appendicitis often also starts in when there is abundant cause of some kind in the way of trauma or over-exertion, which apparently and plausibly accounts for the pain. Always be on guard in these deceptive cases.

8. Note well that a pain exclusively in the left side does not exclude appendicitis. A long appendix and a movable colon due to a long mesocolon can be found anywhere from the left inguinal canal and iliac fossa to the gall-bladder and under the surface of the liver.
9. The temperature in an appendicitis case is of the utmost importance. It ought to be taken at frequent intervals. A moderate temperature, of 99.5° or 100° F., associated with local symptoms in the right iliac fossa, may indicate a gangrenous appendix. This is the group where the general practitioner is most apt to err and defer an operation until it is too late. He ought here, until he feels secure on the basis of his own experience, to consult with a surgeon of experience.
10. Sometimes the leucocyte count goes up before there is any elevation of temperature and is therefore a valuable guide.
11. In a case of typhoid, we do not get an ascending leucocyte count.
12. It is important to remember that the early history of typhoid is often, like an appendicitis, due to swelling of the glands in the appendix.
13. Typhoid appendicitis rarely calls for operation, and it is always a lamentable misfortune to subject such a patient to an unnecessary surgical operation with a long wearing illness before him.
14. Sometimes a man of experience will recognize a grave appendicitis in a case with a dusky or anxious drawn expression, with a slight rise in temperature, and slight but positive symptoms in the right iliac fossa. The general practitioner must cultivate this keen eye which detects the enemy at a glance.
15. Often a patient will present definite local symptoms but nothing can be felt and he has little fever, and the practitioner will rather reluctantly advise an operation; when, however, the patient is on the table, fully relaxed under an anæsthetic, a well-defined mass can be felt and the situation becomes clear and it is evident that an operation was advisable.
16. Of all local symptoms muscle spasm is most important. Remember that a local spasm of muscle guarding a tender area of peritoneum is different from a plastron, or a hard area due to inflammation with surrounding inflammatory products.
17. Remember that a careful examination of urine often serves to differentiate an appendical case from a ureteral calculus at or near the pelvic brim, by showing the presence of blood and pus in the urine. If no abnormal constituents are found in the urine, a calculus is excluded. Occasionally an inflamed appendix adherent to the bladder will cause the presence of blood and pus in the urine, but this is rare.
18. It is better to operate occasionally in error in a doubtful case than to wait too long for more positive signs and to lose a life now and then. No patient is ever killed by a skilful early operation. Many die for want of one.

19. However, this facility with which an operation can be done must not be used as an excuse for slipshod diagnoses and unnecessary operations.

GENERAL CONSIDERATIONS REGARDING OPERATION.

Relations between Physician and Surgeon.—The relations between the physician and the surgeon are a matter of importance, for while it is generally conceded that as soon as an appendicitis is found to be actively progressive a surgeon ought to be called, it is not always understood that he is summoned not merely because his knowledge of anatomy enables him to find and remove the diseased organ, but rather because of his greater diagnostic skill in surgical affections and his more extensive knowledge of their natural history, which cause him to realize more fully the dangers attending each step in the progress of the disease; he is better able, therefore, to decide upon the best time to operate, since the family physician has not always a keen appreciation of those conditions in which a grave prognosis would at once be given by an experienced surgeon. Too often, however, in spite of the multiplied experiences of the last twenty years, does the surgeon still have reason to lament the fact that patients who have been first in the hands of his medical *confrère* are recommended to seek the aid of surgery only when the conviction is overwhelming that an operation is imperative, and at a date too late for him to act with any reasonable assurance of success. My attention has been specially directed by J. E. STOKES to the fact that this happy-go-lucky procrastination is notably the habit in remote rural and mountainous districts, where a consultation is often sought only *in extremis*. But even in our large cities and hospitals, in communities where both the medical periodicals and the constant discussions of our societies conspire to teach men better, the surgeon often has just reason for complaint that he is not given a better chance to demonstrate the safety of operative procedures under suitable conditions. The duty of a physician is aptly expressed in W. W. KEEN's aphorism, "The first indication in appendicitis is to call in a surgeon"; it is the office of the surgeon to determine upon the necessity for an operation, and for this reason he should be asked at the very outset to see the case in consultation with the physician.

After the surgeon has been summoned, the question may arise: What is his duty when operation is advised by him and refused by the patient or his relatives? In a case of well-defined appendicitis with persistent symptoms of a severe type, the proper and dignified course is to retire from the case; but if the surgeon does this, he should carefully state that it is because he is unwilling to stand by, able to relieve and yet helplessly watching the patient who is taking such desperate chances. He ought, as he withdraws, to make it plain that it is always within the limits of possibility, even if it is highly improbable, that a desperate case may recover without operation. If he abandons the case with the unqualified statement that the patient will surely die without operation, and

recovery, as has often happened, takes place, nothing will hurt his reputation so greatly, and, what is of far greater importance, other sufferers, also urgently in need of surgical aid, will be encouraged to take their chances without it, under the impression that his art is mere guesswork. No blame, however, for lack of dignity, but rather praise, should be given to the professional man who, although his urgent advice is not taken, nevertheless, from a sense of duty, and with the assurance that he has not in any degree lost the confidence of the family, continues to watch over the helpless sufferer as he battles for life, with faithful, tender care, exhausting every palliative resource, even to the fatal end.

On the other hand, the surgeon called in late to save a desperate case, ought never, for a moment, to consider his own reputation and the probable fatal outcome, but should always be ready to give the patient, who is usually the innocent victim of circumstances, the slender chance held out by an operation. He should feel that, under these circumstances, he is rendering a valuable service, if he saves but one life in fifty, when without his intervention death is certain.

Removal of the Normal Appendix and the Incidental Removal of the Appendix.—Before discussing the special indications for operation, it is, I think, worth while to consider certain circumstances in general, under which removal of the appendix may be necessary or advisable.

1. Routine removal of the normal appendix as a prophylactic measure.
2. Removal of the normal or the adherent appendix whenever the opportunity is afforded incidentally to do so with safety.

Should the normal appendix be removed as a prophylactic measure? Under the caption "normal prophylactic appendectomy" the question has actually been debated "whether the appendix should be removed in children as a matter of routine, in order to insure them against appendicitis." This question was answered and seriously discussed by 88 American surgeons (*St. Louis Med. Rev.*, March 17, 1900). It is sufficient to declare that the proposition was regarded almost unanimously as "absurd," "unjustifiable," "unsurgical," or "without excuse." The mere entertainment of such a suggestion is evidence of a state of public hysteria, induced by the often sudden and alarming onset of the disease, as well as by the increasing frequency of operations for its relief; but, more than all, perhaps, is it the fruit of constant discussion and fomentation of the subject by the laity and by the daily press; all of which factors combine to bring about a state of panic-stricken uncertainty when each man feels that he may be the next victim. Should appendicitis become still more frequent than at present, this question may again be propounded, when the following data have been secured: first, the actual *pro mille* risk to each individual that he will have the disease; second, the proportion of fatal and non-fatal cases when the disease is let alone; third, the *pro mille* risk from the operation itself.

Should the normal or the adherent appendix be removed whenever the opportunity is incident-

ally afforded by a coeliotomy undertaken for other affections? In urgent and desperate cases of abdominal surgery it is clear that no additional operation is justifiable. The question whether the appendix, normal or adherent, should be removed in simple and uncomplicated cases is one attended with so much interest that I have been at some pains to ascertain the sentiment of the profession in America in regard to it. Fuller data will be found elsewhere (see Chap. XXI); I here note simply that 44 surgeons consulted were against removing the appendix under the conditions stated, while 26 were in favor of doing so. To the second question, namely, the propriety of removing the adherent appendix, 66 surgeons replied in the affirmative, while 7 gave a negative answer. My own opinion agrees with the majority in both instances, and my reasons are given as cited elsewhere.

Whenever the peritoneal cavity is opened for the purpose of removing the vermiform appendix and it is possible to make a further exploration without additional risk, all the abdominal viscera within reach should be examined. The surgeon who habitually explores, in a woman, the uterus and its adnexa, especially the right uterine tube and ovary, will sometimes be saved the mortification of having to perform a second operation to remove a disease which might have been relieved at the first but for an oversight. If the incision is large enough, the right kidney and the gall-bladder ought to be carefully palpated also. Neighboring intestinal adhesions should never be overlooked, and in rare instances a pyo-ureter or a stone in the ureter may be found if the surgeon knows just where to find the ureter at the pelvic brim. In a case which came under my own cognizance, a woman operated upon for appendicitis had an unsuspected inflamed ureter and a pyonephrosis at the same time. It is unnecessary to enumerate the long list of cases in which more or less extensive disease of the right uterine tube and ovary have been found with an appendicitis. It is hardly necessary, I think, to dwell at length upon the risk of intestinal obstruction in closing up the abdominal wound after an interval operation and leaving old bands of adhesions cutting across and binding the intestine. Dr. C. V. COLLINS of Peoria, Ill., writes of this exploration of the abdomen, "It saved me from the deep chagrin of closing the abdomen on a gall-bladder distended with pus after removing an inflamed appendix." Need I dwell at greater length on matters so patent? *Verbum sapienti satis est.*

Indications for Operation.—The operator in appendicitis must always be on his guard lest he open the abdomen only to find there is no disease at all, or, perhaps, a morbid condition entirely unconnected with the appendix, such as an intestinal obstruction, an ileus, a movable kidney, a gall-bladder filled with stones, a pyosalpinx, an ovarian tumor, or an extra-uterine pregnancy. An error in diagnosis is not so serious when there exists a surgical affection in itself demanding operation, for the harm then done is limited to the additional incision needed to reach the unsus-

pected disease, but it is a very different matter when the malady turns out to be nothing more than simple colic with indigestion, or else a case of "peritonism" (GUEBLER). I shall never forget one of my first patients, a young woman who had been under my care for a gonorrhœal salpingitis, for which I had done a radical operation. She called me a long distance from home one Sunday morning for severe pains in the lower abdomen, and I distinctly felt an exquisitely sensitive, nodular mass, behind the uterus. I opened the abdomen with the hope of removing the focus of infection and nipping an acute peritonitis in the bud, but, to my chagrin, discovered only a rectum full of beans, eaten at a late supper and imperfectly masticated.

The group of positive symptoms which the surgeon must keep before him as indications for operation are:

Pain about the umbilicus, or in the right iliac fossa.

Muscle spasm over the affected area.

Tenderness, evident on palpation.

Localized swelling.

Increased pulse-rate.

Elevation of temperature.

Increasing leucocytosis.

Nausea or vomiting.

Constipation.

Ileus.

In a typical case all these symptoms may be present, but the surgeon will often be called upon to decide for or against an operation when several of them are absent; for example, if there is muscle spasm and local tenderness with marked and increasing leucocytosis, or, as ROBERT ABBÉ puts it, "when there is tenderness and muscle spasm with a fairly active onset," an operation is imperative, although other signs are absent. A well-developed local tenderness with muscle spasm and a pulse increasing in rapidity may be the sole symptom in some of the worst forms of appendicitis during the early stages.

Pain.—Pain may be situated in any part of the abdomen during the initial period of the disease; at first it shows a striking predilection for the umbilical region, but a little later it settles down to the affected area in the right iliac fossa. After the pain has once become localized in the iliac region, an increase in its intensity or an enlargement of its boundaries points either to the occurrence of suppuration, or to an extension of the disease into new territory. A sudden cessation of pain may be due to the rupture of an abscess into the bowel, or, in the case of an extensive infection, this may be the first ominous sign of collapse from an overwhelming toxæmia. M. H. RICHARDSON (*Trans. Amer. Surg. Assoc.*, 1899) says, "If pain is severe, and increasing in severity after the early hours, operation is demanded by this symptom alone."

Tenderness.—Tenderness on pressure together with pain are the symptoms simulated by neurotic patients with an appendico-phobia, or "appendicitis on the brain" (OSLER). The surgeon must be ever on the watch to detect these often involuntary malingerers (*sit venia verbo*). As a rule, it is easy to throw them off their guard by engaging them in earnest conversation while examining the painful area, or by using the other hand simultaneously upon some other part of the body and thus confusing the attention. It is a good practice to begin the examination by palpating other parts of the abdomen, especially the left iliac fossa, and so securing a basis of comparison. When tenderness is really present, it constitutes a valuable sign indicative of an underlying inflammatory process, often corresponding to the area outlined. It is well to test the tenderness by first making gentle, graduated pressure with all four fingers, and then outlining the area more precisely with one or two. Tenderness confined to a small area may indicate an inflammation limited to the immediate neighborhood of the appendix or an intra-appendical affection, according to the stage of the disease.

Rigidity.—Rigidity, local in the early stages of the disease, becomes general in a diffuse peritonitis; it is one of the remarkable efforts of nature to put the parts at rest and thus limit the spread of an infection. When present, it constitutes a most valuable sign, perhaps indeed the one sign which comes nearest to being pathognomonic. When associated with localized pain, fever, and a rising leucocytosis, the diagnosis is sufficiently clear to demand operation. Both rigidity and tenderness, however, are absent in some of the worst cases. The decision to employ active measures must then depend upon pain, fever, and increasing leucocytosis, after the possibility of intrathoracic disease has been carefully excluded. RICHARDSON says: "As an indication of spreading infection, tenderness ranks with pain and rigidity. If these symptoms increase in extent, the infection is spreading, when, it is needless to say, immediate intervention is required."

Pulse.—A good full pulse gives a better prognosis in operation than a pulse running up to 120 to 140 and small in volume. If a pulse which has been but little accelerated begins to go up steadily in the presence of other signs of disease, a speedy operation is indicated.

Tumor.—This is the result of adherent intestines, of exudate, or, perhaps, of an abscess with rigidity of the overlying abdominal wall. Sometimes the tumor cannot well be felt because of this rigidity, and an anæsthetic is necessary to relieve the muscle spasm and enable the surgeon to outline the mass below. Unless all the symptoms are decidedly improving, the presence of a tumor is an indication for operation. If it is stationary or enlarging, or if there are signs of pus, an operation ought to be done at once.

Temperature.—Rise of temperature is a most variable sign in appendicitis; it is usually elevated, although rarely high, and occasionally it is almost normal throughout the attack. Fever, in combination with

other signs, constitutes a valuable asset in the diagnostic complex; but in some of the worst cases, requiring immediate operation, the temperature is normal. We may have fever without infection in hysteria, and (in children) with a trifling indigestion. With these exceptions the presence of a persistent fever is generally associated with and a pretty good index of the activity of the inflammatory process. When, therefore, fever is present together with the necessary local signs, the operator may proceed with a comfortable assurance that the lesions under consideration demand surgical interference.

Leucocytosis.—As an aid to diagnosis and an indication for operation the value of the blood-count depends upon the stage at which the leucocytes are counted. Early in the disease, a rising leucocytosis is an indication for immediate operation; later on, when abscess formation has begun, no reliance can be placed upon the leucocyte count. At this stage there may even be a decrease. The variation of opinion at present found among physicians as to the importance of leucocytosis as a guide to operation arises from the fact that the count is made by them at different periods. Those who make a count early in the disease find in it a reliable guide and praise it highly; while those who postpone it until the later stages, derive little or no assistance from it, and consequently deprecate its usefulness.

Vomiting.—Most attacks of appendicitis begin with vomiting, but if the vomiting is persistent, and, above all, if it is associated with constipation, distention, and other local signs of appendicitis, operation is urgent. Later on, a constant vomiting and retching form the most marked signs of a general peritonitis where immediate operation is the only hope.

Ileus.—Of all indications for operation during the attack, ileus, unless of the most transitory character, is, as LENNANDER says, one of the most urgent. It may arise from the violence of the attack, or it may be occasioned by the peritonitis. An ileus appearing at the onset may disappear after the administration of a little opium; when persistent, it usually arises from a fixation of one or more loops of bowel, compressed or kinked in such a manner as to hinder the passage of gas or fæces. The patient vomits constantly, throwing off at first the contents of the stomach and afterward fecal matter. After the lower bowel is emptied, no more fæces pass unless the obstruction is only partial. In many cases these symptoms supervene gradually, and the obstruction does not become complete for some days. The abdomen swells, at first on one side, or in the median line, and the patient is tormented with paroxysmal pain associated with periodical and often visible contractions of the proximal portion of the ileum. Under these circumstances operation is urgently indicated before the persistent distressing symptoms have depleted the vitality. Prompt action is all the more necessary because the operation, in many instances, proves to be one of unusual severity.

Promptitude in Operation.—As soon as an operation is definitely decided upon, each minute of delay is valuable time lost, since in every case of appendicitis there is a moment when relief, possible before, arrives too late; and as this critical period draws momentarily nearer, prompt measures must be taken to anticipate its advent. It is not always the medical man who is responsible for injurious delay in operation, for we find, to our surprise, frequent reports of cases seen by eminent and experienced surgeons who have countenanced a delay of days, or even weeks, in the face of the most pronounced symptoms of the disease, such as extreme pain (quieted by opium), continued elevation of temperature, muscular spasm, and well-defined mass in the right iliac fossa. It is distressing to hear of the golden moments wasted in continued efforts to dissipate these symptoms by purgative drugs. It would be invidious to select illustrative instances here and there from medical literature; it is enough to sound a warning, which should be reiterated until it is effectually dinned into the ears of each rising generation. Our trust is sacred, and whenever we assume the responsibility of life in a dangerous case, we ought to act with the same energy and promptitude in bringing relief and in forestalling danger as we should wish were we ourselves the patients. I do not desire here to criticize the attitude of those members of the profession who are under the conviction that it is better to wait until the affected area is well walled off from the peritoneal cavity, but I do wish to protest against dawdling when the necessity for operation is clearly recognized. A surgeon watching a case with progressive symptoms day after day ought to experience a positive sense of humiliation when he tardily opens an abscess and lets out pus. I have before me the case of a poor fellow, twenty days in the hands of a surgeon, who finally naïvely remarked that "operation now became imperative, and three pints of pus were evacuated"!

Every surgeon who expects to be called on to operate for appendicitis should keep his instruments and other paraphernalia in readiness to be transported to the patient at a moment's notice, so that no time may be lost in sterilizing, in collecting necessary articles, or in packing. A nurse with experience in such cases and surgical assistants ought always to be available. The question of personal convenience ought not to be considered, and the night should be regarded as the day. Two distressing experiences due to delay are frankly related by TUFFIER (*Rev. de chir.*, 1895, p. 705) as a warning to the man who lets convenience, comfort, or engagements delay an operation. In one, a patient with an acute appendicitis refused operation; later in the day the pain increased, and when seen next morning by TUFFIER, he was found with a peritonitis characterized by a dissociation between pulse and temperature; the operation was then planned for five o'clock in the afternoon, but when the hour arrived, the patient was dead. The second case was that of a child who had been ill for three days. The next day was fixed for the operation, but at the appointed time the child was moribund.

Another source of fatal delay may be the desire of the patient or the relatives to await the arrival of members of the family from a distance. If the surgeon is convinced that an operation is imperative, he must not sacrifice the advantages of time to sentiment, but must assume the added responsibility of urging, and even insisting upon instant action. The evils of procrastination are well shown in a case reported by CARMALT (*Amer. Jour. Med. Sci.*, Jan., 1894):

The patient, a college student, was under the immediate care of another physician; the initial constitutional symptoms were severe, but the local evidences of appendicitis were not marked. His home was at a distance, and word was received that his father was hastening on accompanied by his own surgeon. From a natural wish not to seem precipitate, the operation was postponed until such serious symptoms arose that further delay was out of the question; it was then done without the father's presence. Unfortunately the eighteen hours' delay had carried the patient beyond the safe period, and a general septic peritonitis had arisen from the rupture of a thin-walled abscess, associated with a gangrenous appendix containing a fecal concretion.

A common idea prevalent even among the medical profession is that the patient is too weak to stand operation in an acute stage; the notion also prevails in some quarters that hot weather drains the strength, and therefore is a contraindication to active measures. These factors, although undoubtedly deleterious, need not hinder prompt operation in urgent cases.

It may be positively stated that no case of appendicitis where an operation was necessary was ever operated upon too soon, and when the decision to operate is made, no consideration, however plausible, should be admitted as a reason for unnecessary delay.

Operations for appendicitis classified according to the stage of the disease at which they are performed are four in number, namely, early operation, performed at the very outset; intermediate operation, performed from the second to the fifth days; late operation, performed after sufficient time has elapsed for the formation of an abscess; and interval operation, performed between the attacks.

Early Operation.—By early operation we mean one in which the progress of the disease is arrested by surgery before the occurrence of various untoward complications, such as peritonitis, septicaemia, pyelephlebitis, etc. The cases which die in the hands of a good surgeon are those with complications, death being due to exhaustion, sepsis, injury to the bowel, extensive adhesive peritonitis, abscesses formed elsewhere in the peritoneum, above the liver or in the pleura. These complications arise in the course of the disease and are not present at the outset. An operation done in the initial stages encounters none of these risks and is as safe, or almost as safe, as an interval operation. To put the matter a little differently, it is clear that in every appendicitis, no matter how desperate, there existed at one time early in the history a stage in which it could be treated without risk to life, and no surgeon ever

yet saw a bad case in which he did not regret his inability to operate under conditions antecedent by some weeks, days, or even hours.

The opinion of American surgeons from the first has been that early operation is the only safe plan, and many of the best French surgeons now take the same position. The attitude of most of the Germans, on the other hand, is more conservative and strongly in favor of delay, a point of view in which the English surgeons to a large extent agree. The diversity of opinion between American and German surgeons as to what constitutes "an early operation" is nowhere more apparent than in BORNHAUPT's able paper entitled "*Zur Frühoperation der Appendicitis*" (*Langenbeck's Arch. f. klin. Chir.*, 1903, vol. 70, p. 300), in which v. BERGMANN's cases are discussed. He says, in speaking of early operations in Germany: "We divide the cases into two categories. To the first group belong 102, in which there was an encapsulated abscess; to the second group we assign those in which a general peritonitis was found." He adds, farther on, "of an early operation in the restricted sense of the word we cannot speak, as the earliest was after fifty-seven hours."

The ideal time for operation in acute appendicitis is within the first few hours, and not later than the first twenty-four, when the organ can be readily detached from the surrounding structures, and before the formation of an exudation or of an abscess with adhesions among the bowels. If a patient with a frank, well-defined appendicitis is seen at the very outset of the attack, he has a better chance if a good surgeon is available by immediate operation than by waiting. If, however, the surgical skill at command is not all that could be desired, he will do better to take the chances of a spontaneous cure, or to wait for the formation of a localized abscess, which can be opened and drained later on.

Another argument for immediate operation is the fact that the disease has already seated itself in the appendix and made definite progress—who can say how far?—before giving rise to the first recognizable symptom. Also, as W. H. DOUGHTY of Augusta, Ga., insists, acute cases almost always carry with them the signs of antecedent disease, so that we are dealing either with a recurrence or with the culmination of a pathologic process which in most cases has only just reached the point of involving the peritoneum, through which it makes itself known.

It must always be remembered that in the present condition of our knowledge it is impossible to estimate how rapid the progress of an appendicitis will be. In one case of FINNEY's, a hospital nurse was seized with her first attack of pain shortly after coming on duty in the morning, and the operation, performed within three hours of the apparent onset, showed the appendix gangrenous on one side and ready to perforate. In another case of the same surgeon's, the patient, a young physician, operated upon within six hours of the initial complaint, was found to have a spreading peritonitis, and there was every reason to believe that the very first pain he felt was occasioned by the perforation. Both cases recovered.

The advantages of early operation may be summed up as follows:

It is safest, because it can never be foreseen which cases will go on to suppuration and which will not; moreover, fatal complications may arise at any moment, absolutely without warning.

The operation is more easily done, for there are no fresh adhesions, or if there are, they are not dense; there is often no extra-appendical pus, and the appendix is more easily reached than it can be at a later stage through adherent, matted intestines.

The patient is spared days of suffering, for the attack, being cut short, is reduced to a brief surgical illness with rapid recovery, instead of a protracted convalescence of weeks or months. The patient is also saved the pain which inevitably attends the changing of the gauze dressings necessary when drainage is employed.

The liability to recurrent attacks is obviated, and this is not always the case in later operations, for the longer the delay the less the likelihood that the surgeon will find and remove the appendix. It must always be remembered that recovery from the attack does not always mean recovery from the disease. Recovery from the attack may take place under conservative treatment; recovery from the disease, as a rule, is certain only when the appendix has been removed.

An early operation obviates the risk of hernia, which is so common in suppurative cases.

Intermediate Operation.—When the patient is first seen on, say, the second to the fifth day of a frank appendicitis, the question of operation becomes more complex. At this period the surgeon has to consider the difficulties and dangers of breaking up adhesions, together with the associated risk of distributing a localized infection, and some operators regard these as so great that they prefer to wait until a later period, in the hope that the disease will either abate and be absorbed, or else that a well-defined abscess may be evacuated without danger, the case being watched meantime from hour to hour. There is no class of cases which present such difficulty to the conscientious surgeon as these, which we may, for convenience of discussion, divide into three classes:

1. Cases which are manifestly getting worse, as evidenced by continued local pain, swelling, tenderness, muscle spasm, and increasing elevation of temperature, with quickened pulse. These symptoms, together with the facial expression, make up a *tout ensemble* which the experienced eye quickly recognizes. My colleague, W. S. HALSTED, tersely says, "if a case is on the rise, operate; if it is on the fall, you may wait; if a case is falling but not fast enough, one is prone to operate to relieve anxiety." I think that all surgeons will agree with the first part of this statement.

2. Cases in which the patient, although not growing worse, is not distinctly improving and there are sufficient signs of activity to suggest the possibility of latent trouble, should be operated upon at once. Most surgeons, I think, will agree to this.

3. Cases which are undoubtedly on the mend, as shown by improvement in the general condition of the patient, the occurrence of free evacuations from the bowels, and decreasing tympany, together with lessening of muscle spasm over the affected area, lowering of temperature and pulse-rate, and a decrease in the leucocyte count. It is of the utmost importance to remember in such cases that the most marked signs of improvement may be entirely illusory, and the surgeon must be on his guard against misinterpreting that commonly observed but dangerous lull in the symptoms that so often precedes another outbreak of pus or the occurrence of general peritonitis. There is a large group of cases in which, as JACOBSON says, "there may be a mitigation of all and a complete disappearance of most of the symptoms, and yet, during the period of their subsidence, the process of disease has gone on steadily."

It will be seen that the really difficult cases in the intermediate class belong in this division, and any satisfactory conclusion in regard to them can be reached only by a process of elimination. If the patient is in the country, and the surgeon is obliged to return to town, it is safer to operate than to leave him under circumstances where he cannot command the surgeon's services should he suddenly require them. If the patient is so situated that he can obtain surgical aid at once in case of necessity, it is safe to wait, supposing he is kept under hourly observation, and provided the discretion of the physician and the intelligence of the patient can be depended upon, especially if the attack is not a first one. But if the physician's judgment or the patient's intelligence is below par, it is safer to operate than to take the chances involved in waiting under such conditions.

Again, if the patient is in a hospital, it is safe to wait and watch when it would not be so in a private house, because he is under incessant skilled observation and a surgeon can be secured if he is needed without delay. Even these conditions, however, cannot guarantee safety, as shown by the fact that in two or three cases at the Johns Hopkins Hospital perforation occurred under the eyes of skilled professional attendants, and operation revealed a spreading peritonitis. If the physician has no surgical experience, and a good surgeon cannot be had, the patient will stand a better chance without operation, or at least by holding off until a well-defined abscess has formed. The same rule holds good for a surgeon with but little experience, although with improved manual dexterity, a better knowledge of the disease, of the methods of handling infected tissues so as not to spread the infection, and, above all, of drainage, the same man will find that he can give the patient a better chance of recovery by removing the *fons et origo mali* than by leaving it to nature, that is to say, to blind chance. Urgent personal reasons for delay may be admitted in cases of the kind under discussion, where they would be excluded in others. It may be added, as FINNEY says, that the surgeon himself is never so unhappy as when he is watching an appendicitis which has not been operated upon.

Some of our best surgeons are of opinion, however, that operation is indicated under all circumstances. ABBÉ, while dwelling upon the necessity for formulating two sets of rules, one for the surgeon and another for the attending physician, says that "when the diagnosis is made is the time to operate, for there is no case of appendicitis which can be trusted, no matter how simple the symptoms seem to be, and even in the absence of fever, quickened pulse, difficult respiration, or leucocytosis." RICHARDSON also finds himself more and more inclined to operate at any stage of the disease, no matter when it is detected. Finally, I wish to emphasize the statement that no hard-and-fast rule should be laid down as regards operation in this class of cases. Just as it has wrought much harm to hold "the interval" as the ideal time for removal of the appendix, thus inducing men to try to tide over an acute attack in order to reach this desirable period, so in like manner does the prevailing idea as to a so-called "twenty-four hour period" often work detrimentally by conveying the impression that no serious lesion or extension of the disease can take place within the first twenty-four hours, when there is abundant evidence to the contrary. If we must fix a date, it would be better to establish a two-hour rule, and call two hours the safe period, the preparations to operate being hastened in the meantime. Each case must be a law unto itself, and it is as dangerous to generalize here as it would be in plastic surgery to fit a particular pattern to every case; moreover, a rule which is good for an experienced surgeon is dangerous for one with little or no experience. As a matter of fact, most surgeons, even the best, are guided in their conduct toward any individual case by their personal experience in the immediate past, thus demonstrating their fallibility of judgment and lack of precision in a matter where the reverse is of so much importance.

Late Operation. — A late operation, as has been said, is one performed after the formation of a well-defined abscess shut off by adhesions, or else undertaken for a spreading peritonitis. Although the operation for an abscess (suppurative peri-appendicitis) is often a simple and a safe procedure, it is never the procedure of election on the part of a good surgeon, on account of the risks of peritonitis incurred in the delay. FINNEY says: "The presence of pus in an appendicitis case is *prima facie* evidence of a mistake on the part of somebody,—the patient, the physician, or the surgeon. If, however, a skilled surgeon is not available in the early stages of the disease, the patient will run less risk from delay, and the subsequent incision of an abscess, than from a clumsy operation."

Interval Operation.—It is most important to have a clear understanding as to what is meant by the term "interval operation." Many lives have been risked and not a few lost through a misunderstanding and a misuse of this expression. E. M. POND, of Rutland, Vt., expresses this point in a clear and

practical way while speaking of his own *clientèle* in a personal communication: "One of the worst features that I have to contend with is the idea that many have regarding interval operations; the symptoms of the disease appear to them so mild that they take the chances of recovery. You might be surprised if you knew the number of deaths due to delay on this account in this section of country. I am positive that the teachings of those who advocate interval operations account for many deaths from appendicitis. I mean by this that the majority of general practitioners are unable to discriminate between those cases that should have an immediate operation and those that might be delayed, consequently they remind you that 'B—— waits for the interval.'"

The term interval operation is, strictly speaking, a misnomer, as the second attack, or that which is to follow the period of quiescence, is always a hypothetical one. The interval operation depends for its *raison d'être* upon the reasonableness of the presumption that a patient who has had one or more well-defined attacks of appendicitis will in all likelihood suffer from a repetition; it should be clearly understood that in using the expression "interval operation" there is no implied argument that a patient suffering from an appendicitis should risk his life by deliberately waiting until the attack is past to have his appendix removed "in the interval." The interval operation is not for the acute sufferer, but for him who has passed through one or more attacks, and for this reason decides to submit to the operation while enjoying apparent health rather than incur the risk of another, possibly a fatal attack. The cogent reason for performing an operation in the interval of quiescence lies in the fact that the risk to life incurred by operating in the course of an attack of appendicitis is vastly greater than the risk incurred in doing so after all the symptoms have subsided. During this period of complete defervescence the risk is almost, some operators claim quite *nil*. LENNANDER operated on 271 cases without a death. The French surgeons have appropriately distinguished between operations performed during the height of the disease, often marked by febrile disturbances, which they call operations *à chaud*, and those performed after the attack has subsided, to which they apply the suitable term operations *à froid*, a term for which there is no English equivalent. The true purpose of the interval operation is well expressed by the phrase "prophylactic appendectomy" (VIGNARD).

An interval operation, therefore, is one in which the operation is undertaken after the subsidence of the general and local symptoms. The patient is free from fever, his functions are normal, he has recovered his appetite, and feels able to resume his usual occupations, there is little or no pain, the abdomen is no longer distended, there is no spasm of the muscle, tenderness is not marked and there is no mass. And yet (I would emphasize this fact) these signs of a *restitutio ad integrum*, both general and local, satisfactory as they may seem to be, do not define with sufficient precision

the proper time for an interval operation. It is most important not to operate until at least several weeks have elapsed since the acute, severe attack has subsided. Surgeons who operate too early in the interval have in numerous instances opened up small concealed pockets of pus, full of organisms still retaining an enhanced virulence, by which they have inoculated the peritoneum and destroyed their patients in spite of abundant drainage. This error is most apt to occur where there is a little residual abscess at the end of an appendix hanging down into the pelvis. It is better to keep the patient under observation, and to wait from four to six weeks, or longer. We must distinguish clinically between an interval operation in an apparent subsidence of all symptoms, with no tangible evidence of lingering disease, and an operation undertaken for the sequelæ of an appendicitis, when a residual abscess can be plainly felt. This distinction will often rest upon the accidental position of a chronically inflamed appendix, which in one case is easily accessible, and in another lies out of reach in the pelvis.

Desperate Cases.—The question must sometimes arise as to the surgeon's duty in those cases which he first sees *in extremis*. Under these conditions the sole consideration with the operator should be the possibility of saving life, and the experience of the best surgeons shows conclusively that this question must always be answered in the affirmative, unless the patient is actually moribund. There is no surgeon of large experience who has not seen occasionally desperate and apparently hopeless cases recover. The situation may be regarded in this way: A vessel is wrecked and a lot of poor wretches are thrown into the sea. The chance of saving them seems desperate from the shore, but a few determined men put out, and each of them manages to bring in one or two alive. The men ashore excuse their inactivity and their refusal to go, on the ground that they saw clearly they could not save all. Under circumstances where death is certain, every life saved is pure gain, and if but one in twenty, one in fifty, if you will, can be rescued, the effort to accomplish this end is obligatory. An interesting case illustrating this point is given by VAN LENNEP (*Hahn. Med. Month.*, Jan., 1895).

A child of twelve was sent to him after a long illness, with supposed tubercular peritonitis. The abdominal distention was so great, and the child so nearly dead, that the operation was begun almost without anæsthesia. On opening the abdomen, pus poured out as from a geyser, and it was estimated that fully two gallons of it were evacuated. The abscess was bounded by the floor of the pelvis, the abdominal walls, the spine, and the diaphragm; up under the latter the intestines were squeezed into an inconceivably small space. The patient made a surprising, though tedious recovery.

McCOSH and HAWKES (*Amer. Jour. Med. Sci.*, May, 1897) give an analysis of 69 cases of appendicitis treated surgically at the Presbyterian Hospital, New York, between January, 1895, and 1897, the results of which are of considerable interest in this connection. The patients, generally speaking, were brought to the hospital in a desperate condition. "As

a rule," the writers remark, "the ambulance was summoned as a last resource, after medical treatment had been employed for days and even weeks; indeed, several of the patients were sent to the hospital by their friends simply for purposes of euthanasia." The average duration of the acute cases was nine days, the shortest being twenty-four hours and the longest seven weeks. In spite of these untoward conditions the statistics were as follows:

Out of 51 cases operated upon before the development of general peritonitis, there were 50 recoveries and only 1 death. Out of 11 cases in which septic peritonitis developed prior to admission, 9 were operated upon and 2 were not; out of the 9 cases operated upon, there were 6 deaths and 3 recoveries.

The writers especially call attention to the fact that during the second of the two years covered by their report, it had become noticeable that patients were sent to the hospital at an earlier stage of the disease than formerly, and they express the hope that this fact signified a realization of the importance of early operation, not only on the part of physicians, but by the general public. It is evident that in such cases as these the patient has everything to gain by operation and nothing to lose, so that every case saved is clear profit. The only contraindication to operation is the certainty of approaching death, expressed by a small weak pulse, anxious expression, dusky skin, and a composite of signs and symptoms quickly read by the experienced surgeon, but not easily described.

Preparations for Operation.—The operative treatment of appendicitis is daily becoming more and more frequent as its results appear more and more satisfactory. In order to ascertain what proportion operations for the removal of the appendix bear to other surgical operations in our large hospitals, I have collected statistics on the subject from eight large ones in New York, Philadelphia, Baltimore, Boston, Chicago, and found that the ratio varied from one in three to one in twenty-one, in a total of 12,516 surgical operations.

PREPARATION OF THE PATIENT.—The preparation of the patient is often largely in the hands of the medical man who has first seen the case, and the wise physician, having in view the possible necessity of an incision in the abdominal wall, will avoid using any blistering application, such as cantharides or iodine, which are liable to be followed by suppuration, for it introduces a grave risk, namely, the danger of infecting the abdominal cavity. Immediately preceding operation, while the active preparations are under way, a small dose of morphine, $\frac{1}{4}$ or $\frac{1}{8}$ of a grain of. with $\frac{1}{160}$ of a grain of atropine, is often of value in quieting the nervous system, and preparing the patient to look forward with equanimity to the surgical procedure. If the bowels are loaded, a small enema may be cautiously given. All food should be withheld.

Cleansing the Field of Operation.—The field of operation should be cleansed by scrubbing the skin well with warm water and soap, applied with a piece of gauze over the entire right abdomen; fol-

lowing this, a little alcohol or ether may be used to remove fat, and a solution of bichloride 1 : 1000 to further sterilize. The most important feature is the soap and water. If an abscess is suspected, great care must be exercised not to rub too vigorously for fear of bursting it. If there is a suppurating area, following a blister or a mustard plaster, in the line of the incision, it is best to sterilize it with a strong solution of permanganate of potash followed by one of saturated oxalic acid, each of them being applied only for a few seconds, and the surface then scraped.

Posture.—The best posture for the patient is the dorsal one, with the right leg slightly flexed. The Trendelenburg posture is a disadvantage here. Sometimes in exposing the cæcum and appendix it is of material assistance to elevate the right side so that the small intestines will gravitate toward the left and out of the way.

Preparation in a Private House.—Operations must be done with frequency in private houses, owing to the fact that in a large proportion of cases by the time the surgeon arrives the condition of the patient is such as to demand immediate operation and forbid removal to a distant hospital. There is no valid reason why, with due precaution and a satisfactory artificial light at hand, the surgeon should not do as good work in the patient's house as in a hospital. In an interval operation the incision is small, and when closed, sealed, and covered by dressings is no more liable to infection than a similar wound in a hospital. If an abscess has to be drained, it can be done equally well in either place. Some surgeons even find the statistics of their work done in private houses better than those done in the hospital. In a private house there is moreover the advantage of a well-chosen trained nurse working in a spirit of fidelity to both surgeon and patient, a thing not always found in a hospital where the sense of personal responsibility on the part of the attendants is often dulled. The disadvantages of a private house are that, as a rule, serious complications are not so well provided for, moreover the surgeon has scanty time in which to visit his patients.

A well-lighted room should be chosen for operation, if possible near the bath-room. Abundance of hot water must be available, and if there is sufficient time, the room should be cleaned, the floor scrubbed, and afterward a drugget laid upon it and sprinkled. The room must be bared of all unnecessary articles of furniture, such as upholstered chairs, pictures, and mantle ornaments. A single bed must be provided, standing at a height of 26 to 28 inches, including the mattress; an ordinary bed can be made to serve the purpose by placing it on blocks. This will save both surgeons and attendants much awkwardness in the subsequent care of the wound and the bowels, as well as in bathing and turning the patient. Several small tables, about 3×2 feet, should be brought in for the instruments and dressings, and a bench or some chairs provided for the basins of water and solutions. The operating table, which should be a portable folding table like that of Edebohls, must be sent in by the surgeon himself. The operative outfit devised by J. M. T. Finney and Omar Pancoast,

consisting of a trunk, the two halves of which make a long table having six legs, with the tray forming another table, will sometimes be found useful (*Johns Hopkins Hos. Bull.*, 1901, vol. 12, p. 207). A gas stove and an Arnold or a Beckmann sterilizer are necessary for the dressings, towels, and sheets. The surgical instruments should be sterilized at home and packed ready to use on taking them out of the kit.

The instruments and other articles needed in operating at a private house are: Operating table; water and solution basins; scalpels; dissecting forceps (2); artery-forceps (12); retractors; ligature and suture materials; scissors; needles, including fine intestinal needles; needle-holders; gauze for packing and sponges, carefully counted; iodoform gauze strips for drainage, also counted; hypodermic syringe; chloroform, ether, nitrous oxide gas, cocaine, and suprarenal extract; apparatus for saline infusion; towels (about two dozen); culture-tube and platinum loop; a bottle of formalin (10 per cent.) or of alcohol for the appendix.

Only a few of these instruments require any special description. The most convenient retractors are those with blunt teeth, made in a curve. The needle-holder is the Reiner, with the beak made small in order to hold the needles without breaking them. For intestinal suturing I use the delicate, round, French needles with the split eye, and fine black silk (see Fig. 98a). The delicate forceps are of the kind which I use in intestinal, ureteral, and vesical work (see Fig. 99). On grasping the tissues with them but slight injury is done, and at the same time they are adapted to catch up the tissue at any point and hold it for the passage of the finest needles. The mosquito forceps, which I have adopted from the surgical staff of the Johns Hopkins Hospital, are convenient for grasping small vessels in delicate tissues in the peritoneum or about the base of the appendix. I have modified them for the purpose of grasping and retaining tissues by adding a broad point and several teeth.

Anæsthesia.—It is unnecessary to devote time and space here to the discussion of the familiar anæsthetics, chloroform and ether. Ether is to be preferred as a rule on account of its greater safety, but chloroform is the better of the two for children and old people, as well as when there is a tendency to bronchitis, or in the presence of nephritis.

NITROUS OXIDE GAS.—During the past decade sundry efforts have been made to render the process of anæsthetization less unpleasant to the patient and less tedious to the operator. The one method which has proved itself satisfactory is the combined nitrous oxide and ether method, in which nitrous oxide gas is used to induce unconsciousness and followed by the administration of ether. Chloroform cannot be used under these conditions, as it is dangerous to follow the depressing effects of the partial asphyxiation of nitrous oxide gas by such a cardiac depressant.



FIG. 98a.—INTESTINAL NEEDLE WITH SPLIT EYE.

The needle commonly used is often finer still, only three-fourths the size here figured.

The rapidity of the nitrous oxide method is of advantage to the patient, the surgeon, and the anæsthetizer; since the time required for loss of consciousness with the gas is only from one to two and a half minutes and the time necessary to secure complete anæsthesia from one to five minutes. The patient is also relieved from the unpleasant sensations induced by the administration of ether, and in most cases suffers much less from disagreeable after-effects, especially nausea and vomiting. A further minor benefit is the smaller quantity of ether required, the amount necessary to maintain unconsciousness after anæsthesia has been induced by the gas having been estimated at 50 to 70 grams in an operation lasting twenty minutes, up to 300 grams in one lasting three hours and forty minutes.

The only difficulties in the use of the method are an occasional cyanosis during the administration of the gas and an increased secretion of mucus.

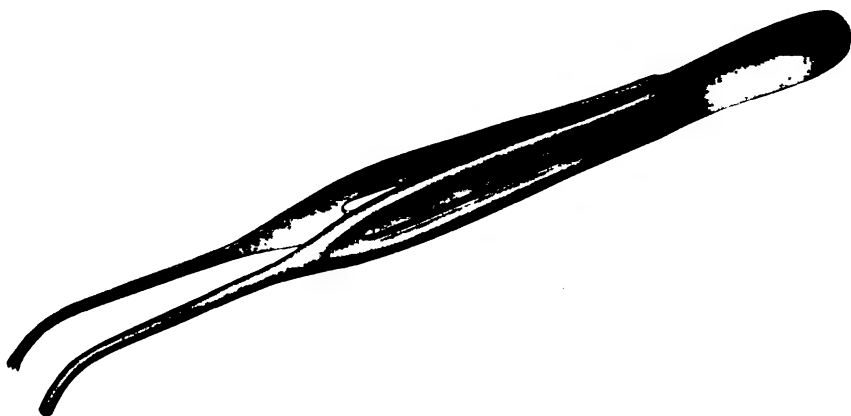


FIG. 99.—DELICATE LIGHT CURVED MOUSE-TOOTH FORCEPS FOR PICKING UP THE BOWEL AND HOLDING IT WHILE THE SUTURES ARE PASSED. (Two-thirds natural size.)

A slight degree of cyanosis is inevitable in most cases, but if the anæsthetizer is experienced and skilful, any marked symptoms of asphyxia are present in but a small number of instances. An increased secretion of mucus is rare, and is always much less than after the administration of ether alone. The nausea also is undoubtedly less and as a rule is absent altogether. Too much stress cannot be laid upon the fact that in the use of nitrous oxide gas the anæsthetizer should be thoroughly familiar with the method, as upon this its success largely depends; most of the instances of failure or of unpleasant results have been due to lack of experience or to want of skill. It is occasionally, but rarely, impossible to secure complete anæsthesia with nitrous oxide gas, owing either to extreme nervousness on the part of the patient or to his being habituated to the use of stimulants.

I first used this method in my private hospital in 1900, and I have since found it most satisfactory in many hundreds of anæsthesias. A brief account of the results attending its use during the first eight months of my experience has been published by my associate, T. R. BROWN ("*On new methods of anesthesia*," *Phila. Med. Jour.*, Nov. 3, 1900).

Nitrous oxide gas has also been employed with good results as the sole anæsthetic in prolonged operations, such as those for removal of the appendix, where disease of the kidneys renders anæsthesia by ether or chloroform dangerous to life. I have tried it in several cases of appendicitis when other anæsthetics were contraindicated for this reason, with excellent results.

My experience in this and other cases has convinced me that nitrous oxide gas can be employed as the only anæsthetic during long operations with perfect safety, and I strongly recommend its use when the existing conditions contraindicate the use of ether or chloroform.

COCAINE.—It frequently happens that an operation for appendicitis is advisable or necessary when the administration of any general anæsthetic is contraindicated by the existence of morbid processes, such, for instance, as chronic pulmonary or cardiac lesions. Under these circumstances the use of a local anæsthetic, such as cocaine, becomes most valuable. An illustrative case is here given:

A young man, twenty-one years old, developed a primary tuberculosis of the larynx at the end of his college career. The opportunity was offered him of recruiting in a remote camp in the Carolina mountains. Under the advice of a specialist he was desirous of taking advantage of this opportunity, but as he had had several attacks of appendicitis during the preceding year, the last of considerable severity, he was afraid of being removed from the possibility of surgical aid for such a length of time. As the removal of the appendix seemed justified by the circumstances, and as the condition of his larynx contraindicated the inhalation of either ether or chloroform, the appendix, which proved to be adherent, strictured, and filled by a concretion, was removed under local cocaine anæsthesia. In ten days he was able to leave the hospital for his proposed outing.

The operation on this particular patient was performed in the spring of 1899, by HARVEY CUSHING, and, so far as I am aware, it was the first in which the appendix was removed under local anæsthesia.

Diseases of the blood-vessels, of the myocardium, or of the respiratory tract, a marked anaemia, a suspected renal insufficiency, an infectious disease, either in itself the cause of the local process or merely a concomitant illness, and many other conditions as well, might be cited as involving considerable risk in administering the usual anæsthetic. The dangers arising from them apply, of course, not only to the operation for removal of the appendix, but to any operative procedures called for during their progress. During typhoid fever, for example, it is well known that the administration of ether or chloroform may have most serious consequences, and only since the introduction and general use of local anæsthesia in these cases has the high mortality rate following operations for perforation and for cholecystitis, as well as for an associated appendicitis, been considerably lowered. On several occasions, cases of suspected typhoid perforation, from the clinic of my colleague, W. OSLER, have been explored under a local anæsthesia, and an acutely inflamed appendix found to have occasioned the symptoms. The removal of the appendix in these cases was not followed by any fatalities.

There are three different methods of using a local anæsthetic for operative purposes, but only one of them is widely applicable to the operation in question:

I. *Segmental anaesthesia*, produced by lumbar subarachnoid injection of the drug, which thus acts symmetrically on the posterior nerve roots of the two sides up to a variable segmental level.

II. *Regional anaesthesia*, in which a certain territory is rendered anæsthetic by injection of a solution of the drug directly into the peripheral sensory nerve trunks, at a distance more or less remote from the operative field.

III. *Local anaesthesia proper*, in which the tissues are infiltrated and divided as encountered in the incision.

The first two of these methods depend for their efficacy upon the physiologic principle of "blocking" sensory impulses, which is a consequence of the local action of the drug.

Segmental anaesthesia has unfortunately many drawbacks. In the first place, it is necessary that a solution of sufficient concentration, namely, 1 to 2 per cent., be introduced into the subarachnoid space, and toxic symptoms are almost invariably seen after this, with fall of blood-pressure and serious symptoms of shock. The reasons which contraindicate a general anæsthetic in critical cases prohibit spinal anæsthetization as well. Although it may not be injudicious to employ this method in selected instances, there has been a very natural reaction against its indiscriminate use.

Regional anaesthesia, so satisfactory in certain operations, such as herniotomy or operations on the neck or extremities, is, unfortunately, hardly applicable to removal of the appendix, when the operative incision lies in a territory overlapped by the lateral and anterior cutaneous branches of two or three of the lower dorsal nerves, each one of which would consequently have to be separately anæsthetized under the borders of their respective ribs before an analgesic cutaneous field could be assured.

Operations for removal of the appendix are, therefore, restricted to the infiltration method, or *local anaesthesia proper*, and the principles of technic belonging to it will be briefly discussed.

Major operations under *local anaesthesia* are, generally speaking, considerably more difficult than those performed in the usual manner. In the first place, it is distracting to the operator to have a conscious patient, and exhausting to be called upon, during a procedure which is necessarily more prolonged than would otherwise be the case, not only to operate, but to assume the responsibilities of sustaining the patient's *morale*. This latter duty should partially devolve upon an assistant, especially detailed to play the part of a "moral anæsthetist," who, by occupying the patient's attention, by encouragement, and by attention to his occasional wants, can do much to relieve the surgeon, although the successful accomplishment of the operation, especially in a nervous patient,

depends largely upon the moral influence of the operator himself. It is needless to say that the sight of an operating room, the noise of instruments, or anything else which might shock the sensibilities of the patient is to be studiously avoided.

The method of operating must necessarily be quite different from that commonly followed. Painstaking and tedious dissection, with absolute hæmostasis, must of course be observed, since the tissues must be kept dry and free from blood-staining, in order that nerves and blood-vessels unexpectedly encountered need not be divided and clamped in a bloody angle of the incision. The tissues must be handled with the greatest circumspection and the usual rough methods of retraction and of sponging are prohibited. Familiarity with the neural anatomy of the region is essential, a subject to which far too little attention is paid in ordinary methods of operating. The accidental division or clamping of a single uncocainized nerve trunk, unexpectedly met with in the parietal incision, may promptly and completely exhaust whatever inhibition the patient possesses long before the peritoneal cavity has been opened. Nerve trunks of any size must be separately anæsthetized, as the infiltration hardly suffices to benumb them, and difficulties are apt to arise because vessels and nerves are likely to accompany one another. Moreover, blood-vessels of any size are, in themselves, apt to give pain when crushed with forceps.

A minimal solution of cocaine, or one of its equivalents, should be used. Eucaine B, for example, is highly recommended by many persons as being less toxic and more resistant to sterilization. As a matter of fact, however, such weak solutions are required for infiltration purposes that toxic effects should never be seen, and the drug withstands high temperatures sufficiently well to waive the latter objection. The solutions most commonly employed are those advocated by SCHLEICH (*Schmerzlose Operationen. Vierte Auflage*, Berlin, 1899), in which the cocaine is combined with small percentages of morphine and sodium chloride. Three such combinations are given by him, varying only in the percentage of cocaine, his No. 2 being as applicable to the general run of cases as any other preparation: Cocaine mur., 0.1; Morph. mur., 0.02; Natr. chlor., 0.2; Aq. destil. ad 100.0.

Weaker solutions than this 1:1000 formula may be satisfactorily employed, even up to a 0.01 per cent. solution; as a matter of fact, an isotonic saline solution, when infiltrated so as to produce a local œdema, has a decidedly deadening influence upon pain transmission.

Necessarily there is always a certain amount of pain inflicted in operating under local anæsthesia, although this becomes relatively insignificant under the management of those experienced in its use. Ordinarily no adjuvant to the drug is called for beyond the influence of moral suggestion, already emphasized. Should such aids be indicated, however, it is well, before the operation, to administer hypodermically a small dose of morphine ($\frac{1}{8}$ grain) and to hold a chloroform mask in readiness to tide the patient

over a difficult moment in the operation, such as may be produced by the introduction of gauze for purposes of "walling off," or by the manipulations required to free a tightly adherent appendix. It is astonishing how a few whiffs of chloroform, not even enough for a "primary anæsthesia," will suffice to accomplish this purpose, and indeed a few inhalations of spirits of ammonia dropped on the mask may be no less efficacious. The performance has in consequence been often referred to as the combined "morphine-cocaine-chloroform" method of anæsthesia.

There are certain steps in the operative procedure itself where especial precautions must be taken. To make the skin incision, in the first place, is a simple matter, provided there has been a linear wheal of local œdema produced by the infiltration. There should be no unpleasant subjective sensation experienced after the first single insertion of the needle, which should be made to follow the spreading œdema in the line of proposed incision. An ordinary hypodermic syringe or two will suffice for the injection, although many persons prefer a syringe with a larger barrel, as it obviates the necessity for exchanging or refilling the smaller instrument. The skin incision may be made immediately after the completion of the subcuticular infiltration; the anæsthetic endures long enough to insure the possibility of a painless closure at the end of the operation, provided a subcuticular running suture is used instead of the through-and-through suture, which would penetrate normal skin outside of the œdematized strip, and so be painful.

The most difficult part of the operation is the parietal incision through panniculus, muscle, and serosa. Care is necessary in going through the fat, since stray filaments of the cutaneous nerves may be met with, and, owing to the impracticability of œdematizing the tissue, such fibres must be dealt with individually. The aponeurosis and muscle belly of the external oblique can usually be opened painlessly in the direction of the muscle bundles, because the chief nerve trunks lie at a lower level, namely, between the transversalis and internal oblique muscles. The incision of election, furthermore, lies more or less parallel with the direction of these main, buried trunks, and, as a rule, midway between the twelfth thoracic and first lumbar nerves, so that the incision may be carried directly down to the serosa without exposing them. Whenever the incision is longer or more vertical than usual, the operator should watch for these nerves, and should the McBurney incision be used, and the fibres of the internal oblique be separated in a line perpendicular to the more superficial opening, both nerves will almost invariably be encountered. The necessity for a clean and bloodless field can thus be appreciated. Should the division of these nerves be deemed essential, one or two drops of a 1 per cent. solution of cocaine may be injected into the trunk, as far dorsally as possible; the peripheral portion, thus rendered anæsthetic, is then divided where necessary.

The parietal layer of the peritoneum, curiously enough, contains sensory fibres, and may need cocainization, although a simple incision through it,

provided it is uninflamed, does not usually give much discomfort. Dragging or pulling of the peritoneum, however, with retractors or with gauze is painful and must be avoided as much as possible.

The abdomen being opened, the viscera may be handled at will. Observations under local anæsthesia on the parietal surface have shown that the visceral serosa is completely devoid of sensory nerves of any sort. LENNANDER has especially called attention to this point in his "*Beobachtungen über die Sensibilität in der Bauchhöhle*" (*Mitth. a. d. Grenzg. d. Med. u. Chir.*, 1902).

The appendix, for example, may be crushed, ligated, or amputated without the patient's being aware of the slightest sensation. The same may be said of any portion of the gastro-intestinal tract, and resections and anastomoses are common enough under local anæsthesia. One reservation, however, must be made,—namely, that any manipulation which causes sufficient tension upon the mesenteric attachment of the viscera will produce pain on account of the stretching of the adjoining parietal serosa. This pain is ordinarily of a reflex, sickening character, and is referred to the area of distribution of the corresponding spinal segments. Thus, in my experience, tension on the mesappendix occasioned by lifting the organ into the wound previous to amputation may cause the characteristic epigastric pain of appendical colic (see HEAD's *Referred Pain of Visceral Disease*). In consequence of this, should the appendix in an interval operation be tightly adherent to the parietal serosa, or should the latter, in an acute case, be inflamed and hypersensitive, a few whiffs of chloroform may be necessary before liberation of the organ can be effected.

Closure of the wound, as a rule, offers no difficulties, provided the skin edges are approximated by a subcuticular suture not passing beyond the area of original œdematization, which remains insensitive for an hour or two.

CHAPTER XVII.

OPERATIVE TREATMENT.

INCISIONS.

It may be laid down as a general rule that the appendix can be reached in all cases where a liberal incision is made anywhere in the right lower quadrant of the abdomen; that is to say, in the space included within the triangle indicated by a line drawn (a) from the umbilicus to the symphysis, (b) from the symphysis along Poupart's ligament to the anterior superior iliac spine, (c) from the umbilicus around to a point on the crest of the ilium midway between the anterior and posterior superior spines (see Fig. 100). No one form of incision is best in all cases, for its location must be adapted to the condition of the abdominal wall and to the stage and peculiarities of the disease. If the abdominal wall is rigid and thick, it is easier to reach the appendix when the incision is made directly over it; if the wall is lax, however, and an incision is made anywhere in the lower quadrant of the abdomen or even in the median line, the wall can be retracted so as to bring the appendix into the opening. Whenever the local signs, such as swelling, tenderness, redness, and œdema, are pronounced, they should determine the site of the incision. In cases in which swelling is pronounced, the incision should be over its most prominent part, rather to the outside, especially if there is a sausage-shaped mass or plastron. When there is no swelling but localized tenderness in the right iliac fossa, the incision should be made at some point between the right rectus muscle and Poupart's ligament. If the pains persistently follow one particular direction, as upward toward the liver or backward toward the kidney, the operator will do well to bear this in mind, and make his incision as much as possible over the course of pain, since the appendix will probably be found in this situation. If the pain is situated in the back, the appendix may lie behind the cæcum, or to its outer side, and it is best to make the incision posteriorly, and work up behind the cæcum. The location of the important nerve trunks and blood-vessels encountered in making the various incisions is shown in Fig. 101.

The conditions necessitating operation must also influence the choice of incision. From this stand-point operations for removal of the appendix may be classified under three heads:

1. The exposure and removal of the appendix for disease confined to the organ itself. In this case the incision is usually made at some point over or near the right iliac fossa.
2. The incidental examination and removal of the appendix during an operation undertaken for morbid conditions elsewhere, such as gall-



FIG. 100.—SHOWING THE MUSCULAR AND TENDINOUS STRUCTURES INVOLVED IN MAKING THE VARIOUS INCISIONS.

On the right side the panniculus is removed, exposing the intact superficial muscle, the external oblique, and the rectus in its sheath. On the left the various muscular structures are seen in their mutual relations in several layers.

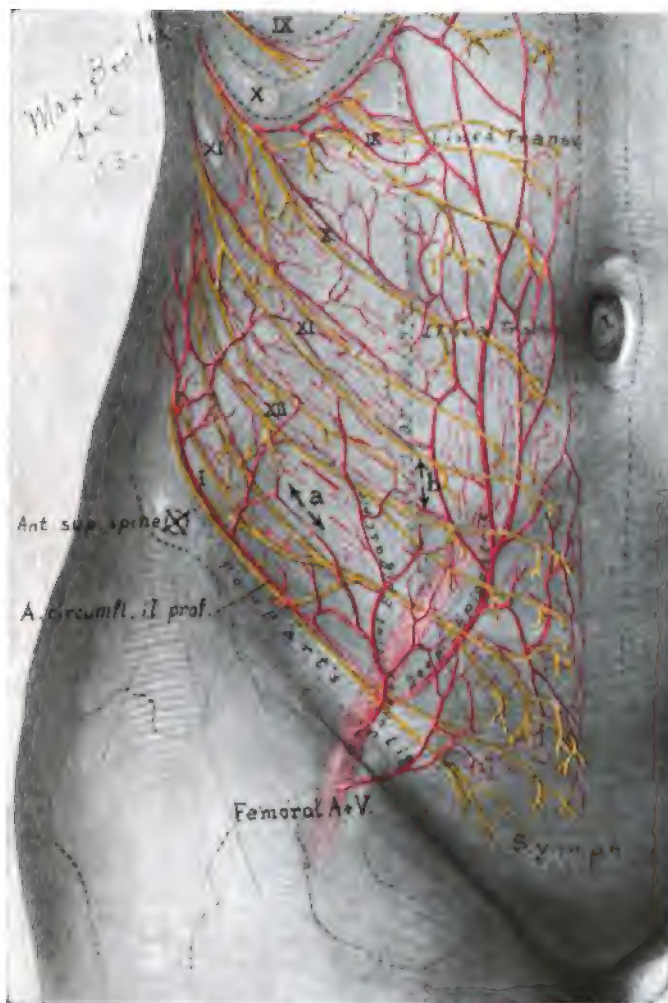


FIG. 101.—REPRESENTING THE PRINCIPAL ARTERIAL AND NERVE-TRUNKS OF THE RIGHT ABDOMINAL WALL.

The larger trunks running obliquely, in the direction of the ribs extended, are found between the internal oblique and transversalis muscles. The smaller branches given off by these pass out toward the skin or deeper into the transversalis. The deep epigastric and the deep circumflex iliac arteries pass in under the surface of the abdominal wall. The arrows at *a* and *b* indicate the position of McBurney's and Battle's incisions respectively. It is of great importance to avoid dividing any of these major nerve trunks in making the incision; this is best effected by blunt dissection.

stones, floating kidney, inguinal hernia, or disease of the pelvic organs. The question then is how to utilize an incision made for another purpose, in order to remove the appendix at the same time.

3. The removal of the appendix during operations rendered necessary by disease of another organ, which disease, there is reason to suspect, is secondary to inflammation of the appendix. In such cases the complication may be situated at some distance from the appendix, and the choice of incision must then be governed by the necessity of relieving both conditions, if possible.

A number of different incisions have been employed by surgeons of ability and experience, and I think it well to give here a brief description of some of these with a few words on the special field of usefulness in each case.

Median Incision.—(See Fig. 102, a a.) This was the form of incision employed in all the earliest cœliotomies for removal of the appendix. So soon, however, as the operation promised to be frequently employed, the utility of an incision in the median line began to be questioned, and as early as 1888 there was a general consensus of opinion in favor of abandoning it for some form of lateral incision, either vertical or oblique (*Trans. Amer. Surg. Assoc.*, 1888, vol. 6, p. 413). The advantages of the median incision are that no nerves or important blood-vessels are encountered, and the closure of the wound is easily effected; it also permits, in women, an easy inspection of and operation upon all the pelvic viscera. Its disadvantage is its distance from the iliac fossa, which often necessitates undue traction to bring the appendix into view, a serious drawback when the appendix is adherent or the mesocolon short. In cases where the abdominal walls have been stretched by a pelvic tumor or by repeated pregnancies, the right margin of the incision is easily drawn over and the right iliac fossa fully exposed, but when the abdominal walls are rigid and thick, as in a nullipara or in a man, the median incision offers a bad route. It is never now deliberately used for the purpose in an uncomplicated appendicitis. It may, however, be employed with advantage for the inspection and removal of the appendix in all cases where chronic appendicitis complicates some graver affection, as, for example, an ovarian tumor, a fibroid uterus, or tubal and ovarian disease on the right side. The peculiarity of the median incision when used under these conditions is that it must be a long one, and should, as a rule, extend not less than two-thirds or three-fourths of the way up to the umbilicus, in order to allow the right border of the incision to be drawn sufficiently far over to the right iliac fossa to bring the appendix within easy reach.

Vertical Incision.—(Fig. 102, b b.) Incision 5 to 8 cm. in length, along the outer border of the right rectus muscle. The advantages of this incision are that, as the deep tissues are purely tendinous, the hemorrhage is slight, and the closure of the wound easy and satisfactory. Its disadvantages are that often it is not directly over the site of the appendix, and therefore the operator in many cases works awkwardly. Moreover, drainage is sometimes difficult. The vertical incision was that employed by MORTON, by

SANDS, and by other of the earliest operators in this country. It was introduced into Germany by SCHÜLLER (*Arch. f. klin. Chir.*, Berlin, 1889, p. 845), and is called by KROGIUS "Schüller's incision."

Sonnenburg's Incision.—(See Fig. 102, g g.) (*Perityphlitis*, 1900, p. 324.) The incision is made close to the ilium, down to Poupart's ligament.



FIG. 102.—CADAVER SHOWING THE LOCATION OF THE VARIOUS INCISIONS FOR THE REMOVAL OF THE APPENDIX IN THE RIGHT LOWER QUADRANT OF THE ABDOMEN.

The body wall is represented as semitransparent in order to show the position of the underlying viscera. *a*, Median incision; *b*, Lennander and Schüller (vertical incision); *c*, Battle's incision; *d*, Morris; *e*, Fowler's oblique incision with extensions; *f*, McBurney; *g*, Sonnenburg, solid line—skin incision, dotted line—deep incision along Poupart's ligament; *h*, Edebohls' incision for both kidney and appendix.

It is seldom necessary to divide the epigastric artery. The layers divided are: The skin, the superficial fascia, the external oblique muscle, the internal oblique muscle, the transverse muscle, the transverse fascia, and, finally, the peritoneum. A branch of the circumflex artery must usually be tied off, and also a large vein which runs outward in the direction of the incision.

G. R. Fowler's Incision.—(Oblique Incision, *Treatise on Appendicitis*, 1894, p. 156.) (See Fig. 102, e e.) Incision two to three inches long, the middle of which intersects at right angles an imaginary line drawn from the right anterior superior iliac spine to the umbilicus. The direction of the incision, therefore, is not quite parallel to Poupart's ligament, though

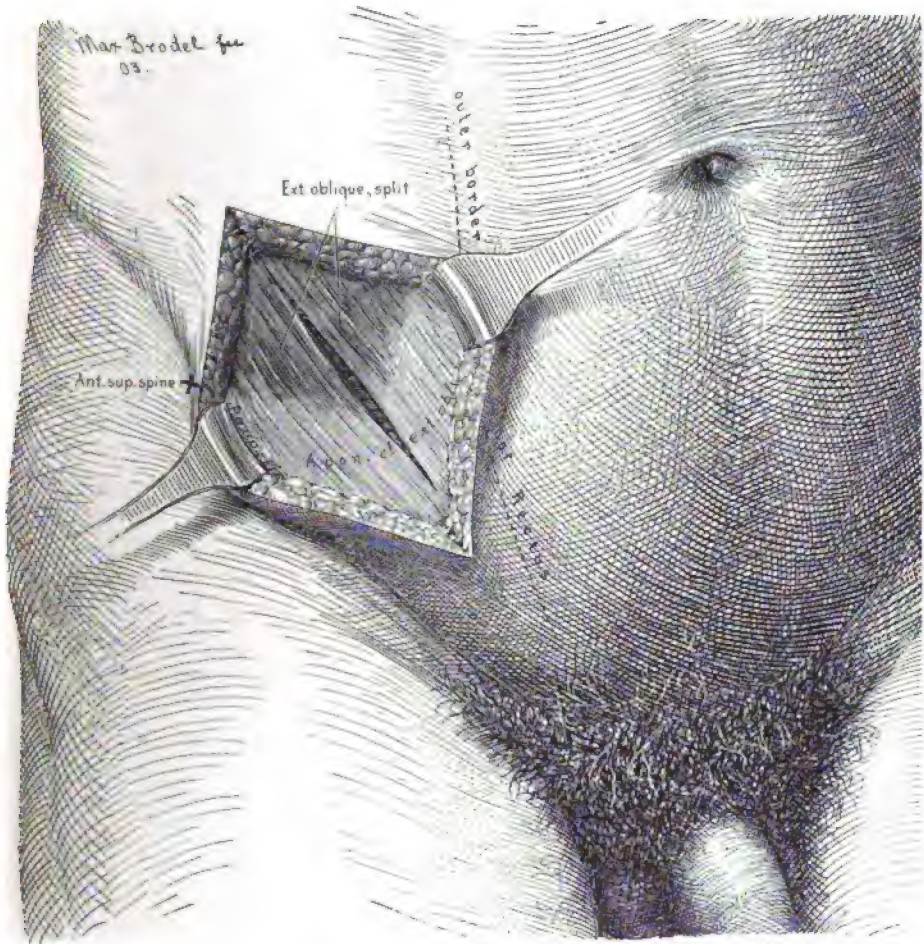


FIG. 103.—MCKURNEY'S INCISION (II).

Skin retracted, exposing the external oblique muscle and its aponeurosis; the muscular fibres are only found in the upper half of the exposed area. The division is made in the line indicated by the separation of the fibres in the figure.

it is frequently spoken of as being so. The structures divided are the skin, the superficial fascia, the external and internal oblique and the transversalis muscles, the transversalis fascia, and the peritoneum. It has the advantage of giving ready access to the appendix and of being easily extended upward or downward; however, it is frequently followed by hernia in cases requiring drainage.

Roux's Incision.—(*Rev. med. de la Suisse Rom.*, 1890, vol. 4, p. 325.) The oblique incision was introduced into France by ROUX, with a slight variation in method by which the peritoneum, when it is reached, is incised only in the superior external part of the wound just over the cæcum, and not enlarged unless it is necessary to do so.

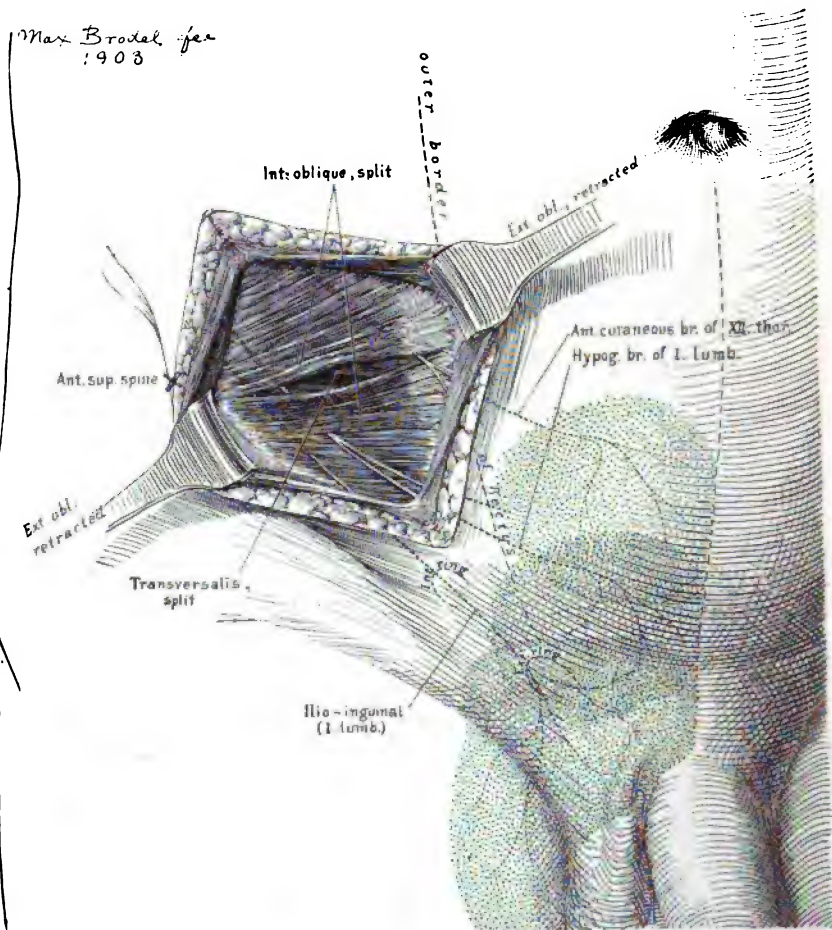


FIG. 104.—MCMURNEY'S INCISION (III).

Showing the skin with the external oblique muscle retracted, and exposing the internal oblique, which is also slightly drawn apart in the direction of the incision about to be made, exposing the transversalis muscle below. The fibres are divided where they are longest. The important point at this stage of the operation is to avoid injury to the nerve trunks readily found crossing the upper and lower portions of the field. An injury to the muscular or cutaneous branches of the twelfth nerve is followed by muscular paralysis or by an anæsthetic area over the zone indicated. Injury to the ilio-hypogastric nerve, seen just above the ilio-inguinal, produces similar disturbances in the lower zones of the rectus and the skin. The arrangement shown is that most commonly found.

C. McBurney's Incision.—("Gridiron.") (*Ann. Surg.*, July, 1894, p. 38.) Incision about four inches long, crossing at right angles an imaginary line drawn from the right anterior iliac spine to the umbilicus, the upper third of the incision lying above the line. (See Fig. 102, f f.) The section

of the external oblique muscle must correspond with that of its aponeurosis, no fibres being cut across. (See Fig. 103.) The edges of the external oblique are then pulled apart by retractors in order to expose the internal oblique, whose fibres, as well as those of the underlying transversalis muscle, are now separated with a blunt instrument in a direction parallel to their course, which is nearly at right angles to the incision previously made in

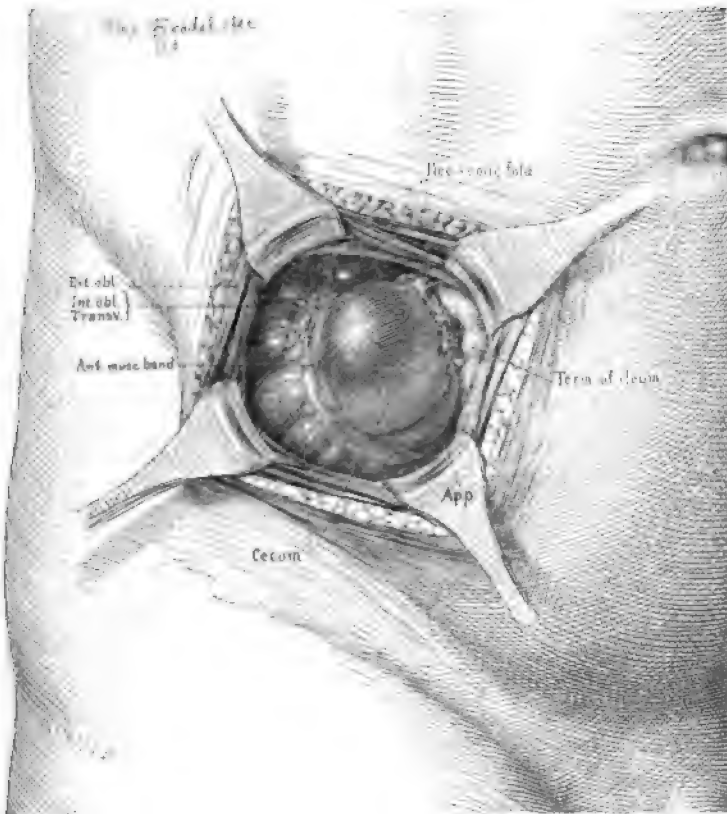


FIG. 105.—McbURNEY'S INCISION (IV).

Showing the excellent exposure of the cæcum and structures adjacent to the appendix. The size and position of the opening can be materially altered to meet changing conditions, such as an abnormally placed appendix, by traction in one or another direction.

the external oblique. (See Fig. 104.) Not more than an occasional muscle fibre need be cut. The edges of the opening are then separated by blunt retractors, thus exposing the transversalis fascia, which is divided in the same line as the muscle. Finally, the section of the peritoneum is made. The perfect exposure secured in this way is shown in Fig. 105. After the appendix is removed, the wound in the peritoneum is closed by suture; the fibres of the transversalis and of the internal oblique fall together as soon as the retractors are withdrawn, and their closure is made complete

by a couple of fine catgut stitches. The wound in the external oblique is sewed with catgut from end to end. This method was devised for the purpose of obviating the occurrence of hernia, a common sequela after vertical or oblique incisions. The abdominal wall owes its strength largely to the gridiron-like arrangement of its muscular and tendinous fibres, and as in this operation these fibres are not cut but separated, their normal arrangement is not disturbed, and the strength of the wall after the operation is finished is almost as complete as if no operation had been done. This method possesses the additional advantage of causing no bleeding except from the incision in the skin, and little or no post-operative pain,

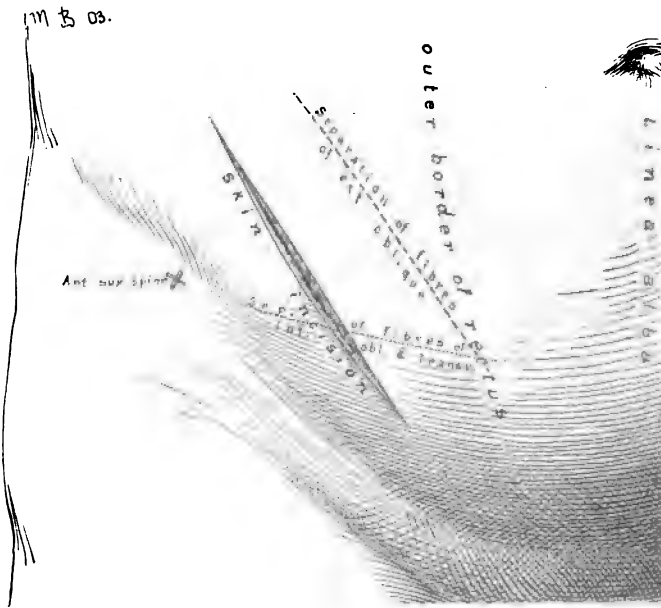


FIG. 106.—FINNEY'S INCISION.

Showing marked disassociation of skin and muscle incisions for the purpose of protecting the deep wound.
The deep incisions are those which are displaced.

since no nerves nor muscle fibres need be divided. FINNEY's modification of the MCBURNEY incision is shown in Fig. 106.

Incision in the Semilunar Line.—(See Fig. 102, c c.) (BATTLE, *Brit. Med. Jour.*, 1895, vol. 2, p. 1360.)* This is a vertical incision of variable length in the right iliac region, following the direction of the linea semilunaris. The middle of the incision corresponds to a point where, in the opinion of the surgeon, the appendix will be found. The skin and the subcutaneous tissue are incised, and the aponeurosis of the external oblique is

* Battle's original publication in 1895 was very brief, scarcely more than a note, and possibly for this reason was almost entirely overlooked. After the appearance of other claims he published a second paper describing his method at greater length (*Brit. Med. Jour.*, 1897, vol. 1, p. 965).

exposed as it spreads over the rectus muscle. The outer part of the sheath of the right rectus is then incised, and the muscle, having been separated from the sheath with the forefinger, is drawn toward the median line. (See Fig. 107.) On retracting the muscle the deep epigastric artery is seen lying on its posterior sheath, but this is easily avoided. The thin posterior

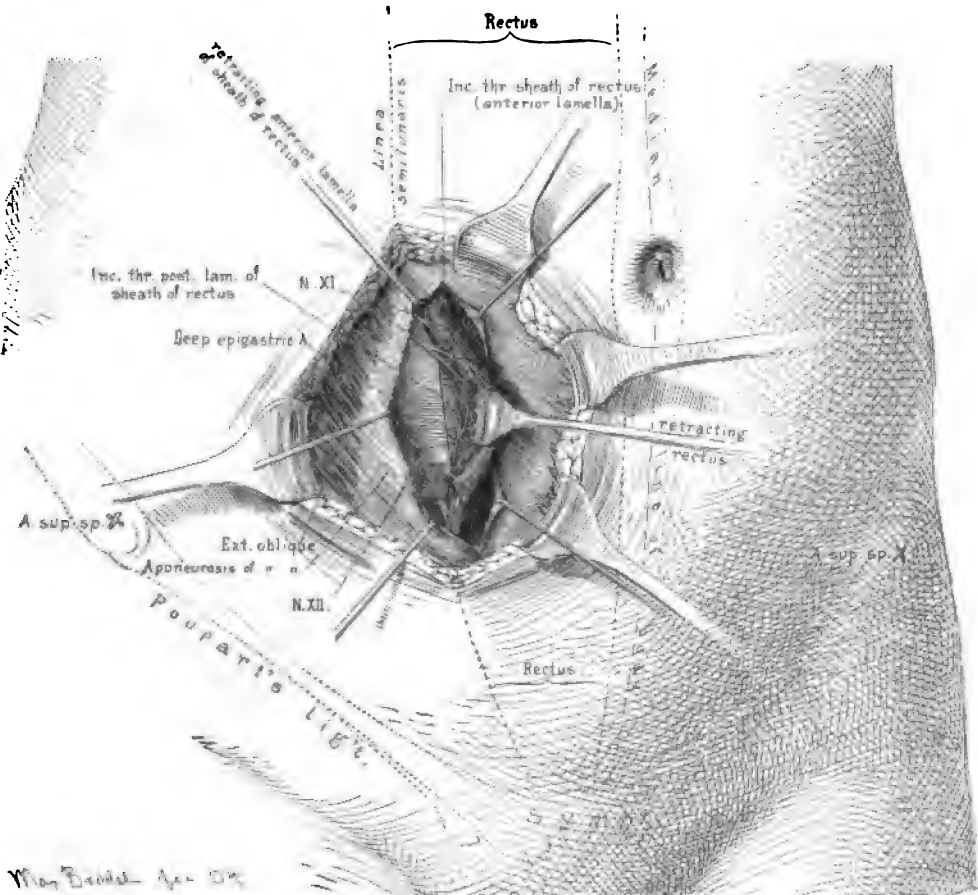


FIG. 107.—INCISION IN SEMILUNAR LINE OPENING THE RECTUS SHEATH AND EXPOSING THE DEEP EPIGASTRIC VESSELS UNDER THE RETRACTED RECTUS MUSCLE.

Note carefully the nerves exposed and implicated. The subsequent incision through the posterior sheath of the rectus is indicated by the vertical line.

sheath of the rectus, the subperitoneal tissue, and the peritoneum are all divided to the full extent of the incision. After removal of the appendix, the wound is closed by interrupted silk sutures in three layers from behind forward. The posterior part of the sheath and the structures behind the muscle are brought together in one line of sutures, after which the rectus muscle is allowed to return to its normal position. (See Fig. 108.) The anterior part of the sheath, with its external oblique aponeurosis, is next

sutured, and finally the subcutaneous tissue and the skin. This method has the same advantage as that of MCBURNEY, namely, the avoidance of hernia as a post-operative sequela. It has also the same disadvantage of requiring a slightly longer time than the simpler operations.

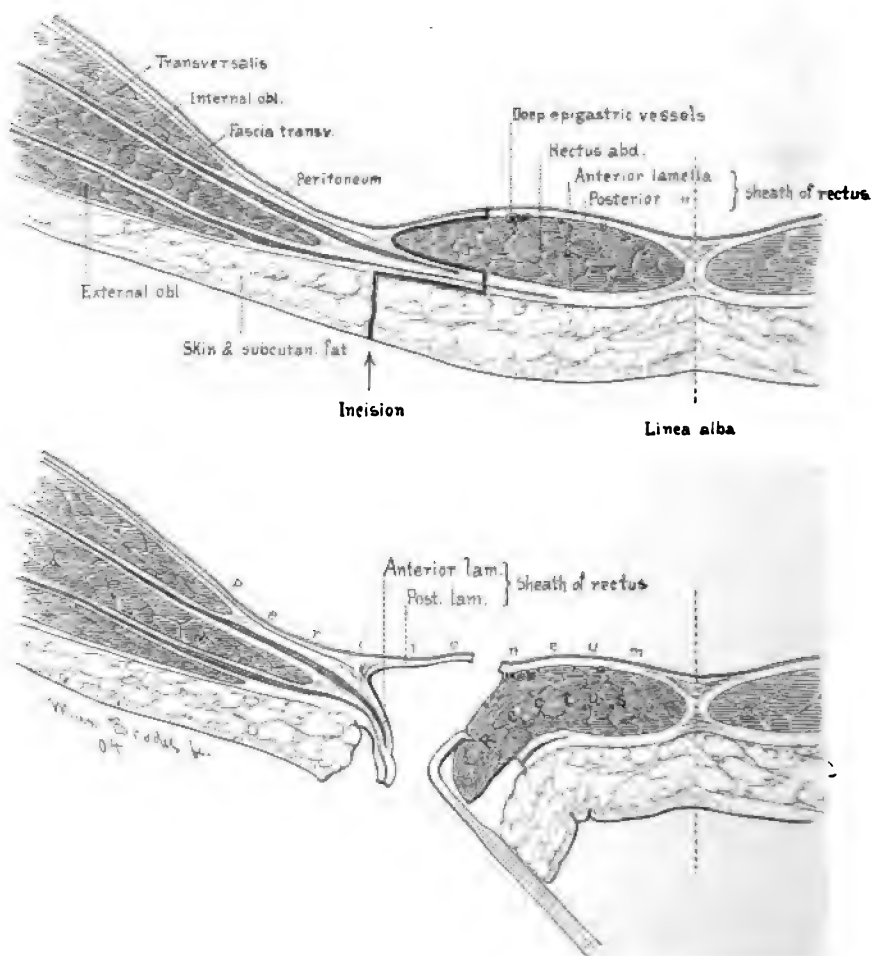


FIG. 108.—SHOWING THE DIVISION OF THE STRATA OF THE ABDOMINAL WALL IN THE INCISION OVER THE SEMILUNAR LINE.

The upper figure shows the direction taken in the incision, while the lower shows the tissues divided and retracted.

This incision has also been independently advocated by KAMMERER (*Ann. Surg.*, 1897, vol. 26, p. 225); JALAGUIER (*Presse med.*, 1897, vol. 5, p. 53); and LENNANDER (*Centralbl. f. Chir.*, 1898, vol. 25, p. 90).

R. T. Morris's Incision.—(Short Incision.) (*Med. News*, April 7, 1894). (See Fig. 102, d d.) Incision $1\frac{1}{2}$ inches long exactly over the site of the appendix in a line following the direction of the external oblique fibres. The distal end of the incision terminates at the right margin of the right

rectus muscle. After cutting the skin the muscles and fascia are separated by blunt dissection. The transversalis fascia and the peritoneum are then picked up on a hook, and a guy-line made of a strong thread of catgut is passed through them. A forceps is then snapped on the loose end in order to keep the guy-line out of the way, and left there until the wound is closed. After the removal of the appendix the retracted margins of the divided transversalis and the internal oblique aponeurosis, as well as the peritoneum, are brought up into sight by traction on the guy-line. They are then closed with one suture of catgut; the guy-line is cut away, and the external oblique with its aponeurosis is closed with one or two uninterrupted sutures. While the skin is being closed it is kept on the stretch, and care is taken not to include any fat in the suture. The advantage of so short an incision is that it reduces the length of convalescence, the patient being in bed only one and a half weeks, and that it leaves an almost imperceptible scar. It is unavailable where there is pus or when complications are present. The right tube and ovary and the posterior surface of the uterus are all that can be explored through this incision. The disadvantages and dangers of it lie in the fact that unexpected conditions are very often encountered, and the peritoneum as well as the wound is seriously contaminated before the operator is aware of the fact.

G. M. Edebohls's Incision.—(Lumbar.) (*Amer. Jour. Obst.*, 1895, p. 165.) (See Fig. 102, h h.) This incision is employed only when the appendix is removed during an operation undertaken for suspension of the kidney. The incision is the same as for a suspensory operation, but it is extended farther down across the loin in the direction of the anterior abdominal wall, so as to bring the anterior portion of the incision into relation with the peritoneal cavity and the ascending colon. The peritoneum is then opened to the outside of the ascending colon. This method is never indicated except as an accompaniment to right nephropexy.

My own custom is to use MCBURNEY'S incision when no pus is present, as is the case in most interval operations, and BATTLE'S (semilunar) incision when an abscess must be evacuated and there is necessity for extensive packing with gauze. In exceptional cases, when there exists a mass of peculiar form or location and the diagnosis is uncertain, I sometimes find it advantageous to make two incisions. The first, which is purely for exploration, corresponds to Battle's incision. After finding the exact location of the mass and its relation to the peritoneum, a second incision is made over the mass or somewhat laterally to it, while one hand is inserted through the exploratory wound for guidance. Before the infected area is entered the first incision is closed.

Closure of the Incision.—After a perfectly aseptic operation the incision should be closed by means of cumol catgut or fine silk, the tissues being united layer by layer in an order the reverse of that in which the incision was made. The peritoneum should be closed by a continuous catgut suture. The transversalis muscle is rarely sufficiently developed to call for a special suture. After this the internal oblique is united, preferably by interrupted

sutures. The external oblique then follows, its aponeurosis being united by interrupted sutures. Lastly, the skin wound is closed by a continuous subcuticular suture of catgut, silkworm-gut, or silver wire. In all doubtful cases it is best to close the wound only in part, leaving an opening for drainage. The dictum of A. WORCESTER, of Waltham, Mass., uttered on this subject over fifteen years ago, is the opinion of all experienced surgeons to-day: "Many a patient has been sacrificed after an otherwise good operation by the close suturing of the abdominal wound" (*Bost. Med. and Surg. Jour.*, Aug. 4, 1892). C. P. NOBLE lays great stress upon the overlapping of the tissues as an important factor in the subsequent strength of the abdominal wall (*Amer. Jour. Obst.*, 1897, No. 4).

REMOVAL OF THE APPENDIX.

Two things must be striven for in the surgical technique of the removal of the appendix: First, to make the operation as easy and safe as possible in the hands of experienced surgeons; second, to convert the complex into the simple.

Exposure of the Appendix.—The first care of the surgeon after opening the abdominal cavity should be to explore the area surrounding the cæcum, in order to note the presence of swelling or induration, as well as of intestinal or omental adhesions. The following local conditions may give rise to an error in diagnosis:

- A tumor of the right ovary.
- Inflammation of the right ovary or tube.
- Extra-uterine pregnancy.
- Worms in the intestinal canal.
- A Meckel's diverticulum.
- A stone in the right ureter.
- A movable right kidney.
- Intestinal and omental adhesions.
- Stones in the biliary tract.

An error is most likely to occur in cases of right-sided pain in women, and here the first step should be to always examine the condition of the tube and ovary on the right side. A movable kidney is frequently mistaken for an appendicitis, and when there is no visible affection of the appendix the kidney should be grasped and the extent of its mobility tested by gentle traction. The gall-bladder will in some instances be found to contain stones the removal of which will clear up the diagnosis. Intestinal and omental adhesions should always be sought out and separated if present. The right ureter can be inspected on the pelvic brim just to the inside of the ovarian vessels; if there is a stone at this point, it can readily be seen, and if it is lower down, the ureter will, as a rule, be found dilated. Round

worms are sometimes felt through the wall of the small intestine, and can be killed by squeezing or needling, after which the dead worms will be found in the stools. A Meckel's diverticulum should be looked for along the free border of the ileum, beginning at the valve and examining the bowel for a distance of three feet or more. The symptoms of an inflamed or perforated Meckel's diverticulum are often precisely the same as those



FIG. 109.—THE APPENDIX HERE LIES IN A LARGE-MOUTHED RETROCAECAL POCKET.

In this case the border of the omentum was adherent on the outer side of the sac, and is indicated by the little remaining mass. The significance of this position of the appendix in relation to abscess is evident. Note the well-developed appendico-ovarian ligament pathologically produced. (Natural size.)

arising from an appendix similarly affected. In all cases in which the abdomen is opened *for appendicitis* the appendix must be removed when it can be found, whether it appears normal or not, for strictures and minute ulcerations of the mucosa may be present which produce no alteration of the peritoneal surface recognizable to the naked eye.

In a favorable case the appendix may slip out of the incision at once; if it does not do this, it must be sought for by feeling with the thumb and

forefinger, the *tænia* muscle serving as a guide. Sometimes, however, a band passes from the *tænia* across the *cæcum*, which tends to mislead the operator very seriously in looking for the appendix, should it lie behind the *cæcum* and beneath the ileum. Search should always be directed to the iliac fossa below the *cæcum*; then to the pelvic cavity, where the appendix may sometimes be found hanging over the brim of the pelvis, or even along it; then to the inner side of the *cæcum* in the angle between the *cæcum* and the ileum; then to the outer side of the *cæcum* (see Fig. 109); and, finally, to the posterior part of the *cæcum*. If the appendix occupies the retrocæcal position, as it does in a large number of cases, it is discovered, after the exclusion of other positions, by lifting up the *cæcum* with the *tænia* muscles in view, and inspecting the point at which the appendix disappears behind the bowel. If the appendix is of the retrocæcal extra-peritoneal type, it is then exposed to view by incising the *cæcum* on its outer side, and detaching the bowel from the iliac fossa until the whole posterior surface of the *cæcum* lies bared. An extreme case of this type is shown in my "Vermiform Appendix," p. 542, Fig. 255, in which the appendix could only be brought to view by an extensive dissection, begun on the outer surface of the *cæcum* and colon and carried inward. Another unusual case, in which the appendix, although intraperitoneal, lay completely to the inner side of the *cæcum* and colon, is shown. An interesting group of cases is formed by appendices trapped within peritoneal recesses and pockets, as shown in Fig. 76, p. 109. Such a case has recently been reported to me by Dr. J. HALPENNY of Winnipeg, Manitoba. A girl of twenty had a colicky pain over the appendix, but there had been no previous attacks. At operation, the appendix, shrunk and doubled upon itself so that its lumen was completely occluded, was found in a pouch formed by a wing of slightly fibrous tissue joining the *cæcum* to the colon. There were very few adhesions. Search for the appendix must always be carried on with the utmost caution, and the operator should be ever on his guard, since the incautious lifting of a loop of bowel or the separation of some trifling adhesion may prove sufficient to let loose the contents of an abscess, hitherto scarcely restrained by an insufficient barrier. In order that the operator may carry clearly in mind the various sites in which the appendix may be found, as well as the different attachments, as he opens the abdomen to find and remove it, a graphic presentation of these varying positions is given in Fig. 111.

Operations for the removal of the appendix may be divided into two classes:

1. Typical—In which the infection is localized in the appendix and can be readily isolated from surrounding structures.
2. Atypical—(a) In which the appendix is densely adherent to some other structure. (b) In which the appendix lies behind the *cæcum*. (c) In which the disease of the bowel is not limited to the appendix, but involves the adjacent part of the *cæcum* as well.



FIG. 110.—EMBRYONIC DISPLACEMENT OF THE APPENDIX, WHICH IS BURIED IN ADHESIONS UNITING THE COLIC FLEXURE TO THE GALL-BLADDER, AND IS BOUND DOWN TO PRE-RENAL PERITONEUM.

This picture is invaluable in explaining the occasional association of appendicitis with cholecystitis and pyelitis. Autopsy December 2, 1901. J. G., col., æt. fifty-five. Carcinoma of stomach, metastases. (Three-fourths natural size.)

Typical Operations for Removal of the Appendix.—The one feature common to all operations for removal of the appendix is the ligation of the

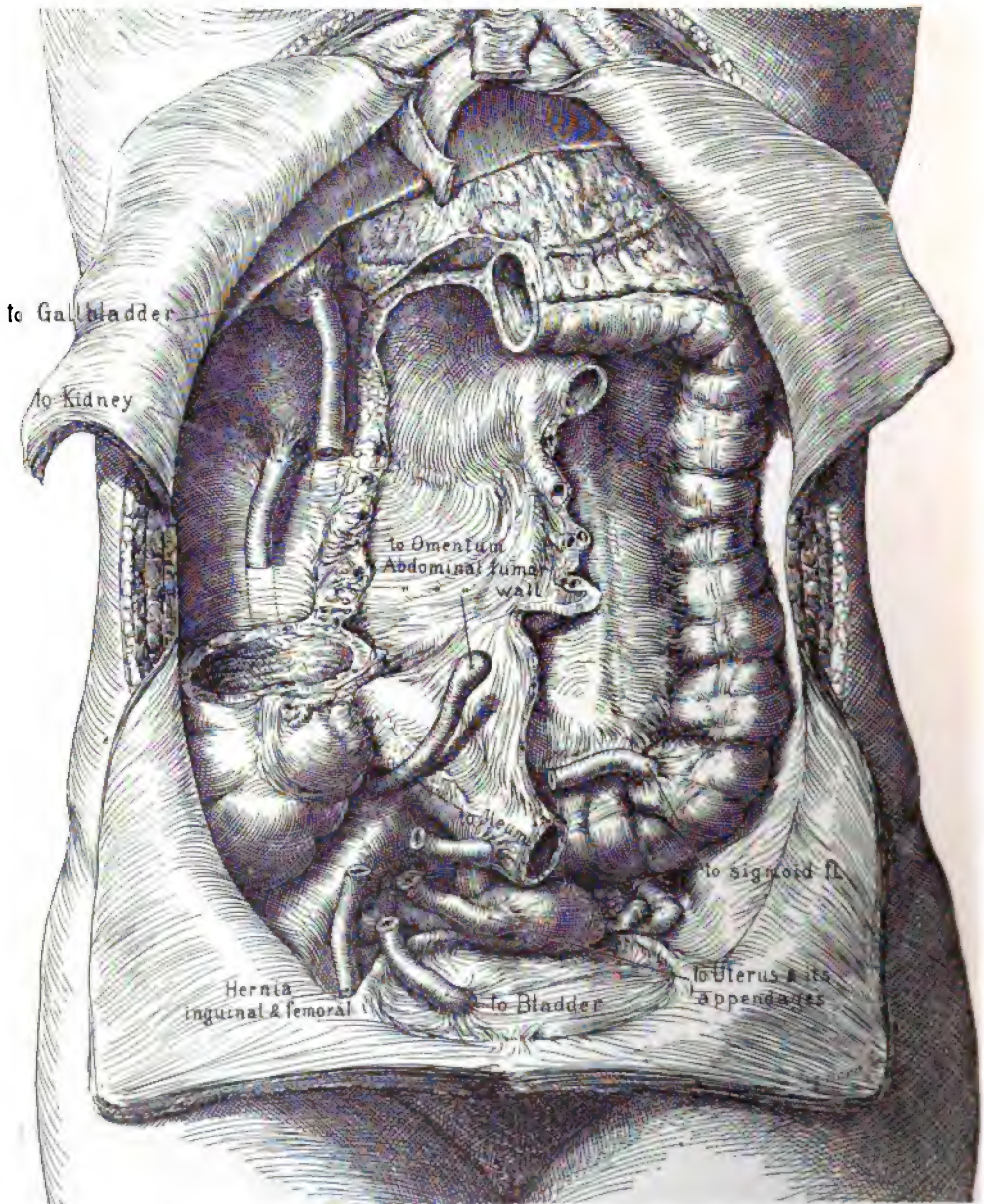


FIG. 111.—A COLLECTIVE PICTURE SHOWING THE VARIOUS POINTS OF ATTACHMENTS OF THE VERMIFORM APPENDIX TO GALL-BLADDER, KIDNEY, ABDOMINAL WALL, ILEUM, UTERUS AND ADNEXA, SIGMOID FLEXURE, BLADDER, AND HERNIAL SAC.

mesappendix so as to control the vessels. This ligation begins on the free border, so as to control the vessels of the mesentery, and is continued onward

as far as the cæco-appendical angle, a little on to the surface of the appendix. It is important for the surgeon to familiarize himself with the varying conditions in the vascularization of the appendix and the adjacent cæcum, in order that the ligatures may be applied so as to control the hemorrhage and at the same time avoid cutting off the circulation of any portion of the

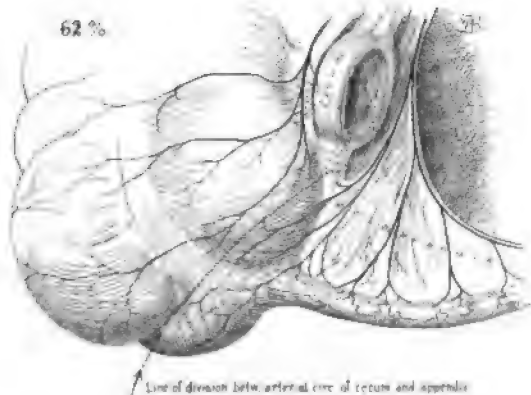


FIG. 112.—THE COMMONEST TYPE OF CIRCULATION AT THE APPENDICO-CÆCAL ANGLE.

Follow the dotted line which indicates the division between the cæcal and appendiceal vessels in this and the following diagrams. The dotted line represents the maximum area (62 per cent.).

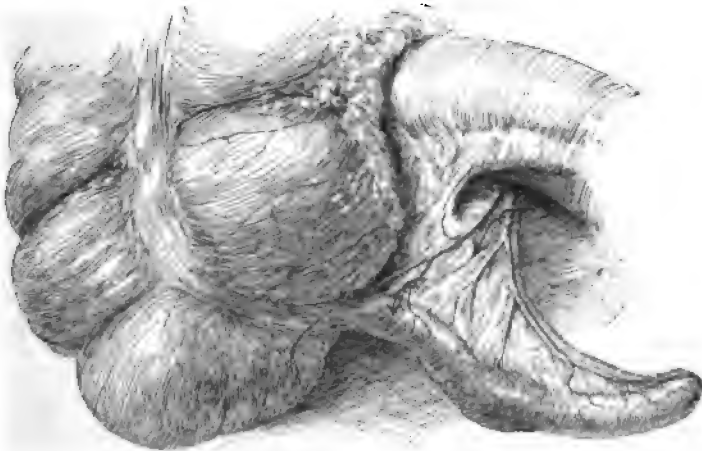


FIG. 113.—NORMAL TYPE, NON-ADHERENT APPENDIX.

The circulation is best controlled by locating the vessels in the mesappendix, and then ligating only the main trunks which supply the appendix, sparing any important branch going to the cæcum, as shown in the diagram.

cæcum. The line of division between the arterial supply of the cæcum and of the appendix in 62 per cent. of the cases is found well out on the cæcum (see Fig. 112). It is manifest that, for this reason, it is of advantage not to tie all the appendiceal vessels at too high a point. Fig. 113 shows the best methods of ligating in such a case, sparing the last cæcal artery, and thus insuring a maximum nutrition to the parts during the healing process.

In 32 per cent. of the cases the circulation is neatly divided at the base of the appendix (Fig. 114), and here the ligature may be applied high enough to give perfect control of all the vessels. Again, in 5 per cent. of the cases we have a condition in which the cæcal artery supplies the proximal portion of the appendix (Fig. 115). It is in such cases that we must be on our

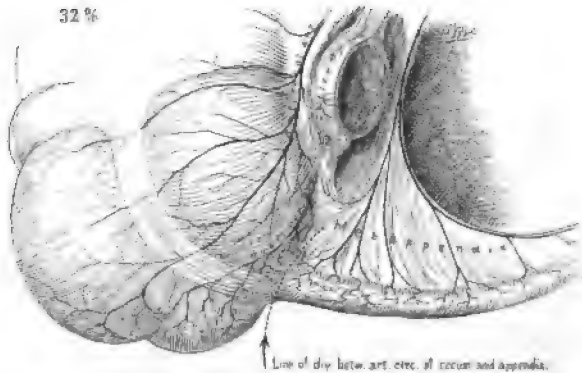


FIG. 114.—THE APPENDICAL AND CÆCAL SYSTEMS ARE HERE ENTIRELY DISSOCIATED (32 per cent.).

guard against bleeding after amputation, and especially for the occasional case (see Fig. 116) in which there is a broad arterial anastomosis between the cæcal and the appendical vessels in the little mesentery.

It sometimes happens that the mesappendix is so short that the main trunks cannot be exposed above; in such cases it will be necessary to tie

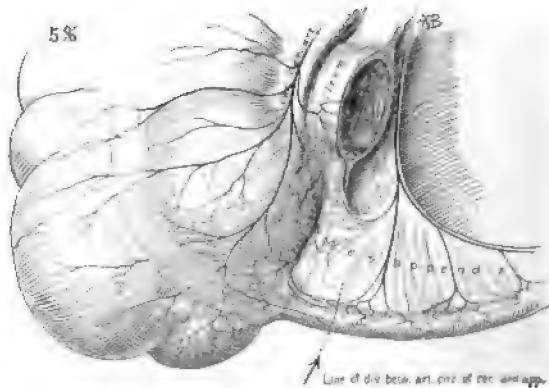


FIG. 115.—THE CÆCAL VESSELS HERE SUPPLY THE ROOT OF THE APPENDIX (5 per cent.).

the vessels singly (a procedure some physicians elect by preference) close to the appendix, as shown in Fig. 117. When the appendix lies to the outer side of the cæcum, and the mesenteriolum is closely attached, as shown in Fig. 118, it is always safer to control the terminal vessels close to the appendix, proceeding as a rule from tip to base, although it may seem best to begin by clamping and amputating the appendix at its base. The entire operation may be performed with clamps instead of ligatures.

In dealing with the stump of the appendix it is important to avoid two things: first, the simple ligation and amputation, leaving the mucous membrane exposed, whether sterilized or

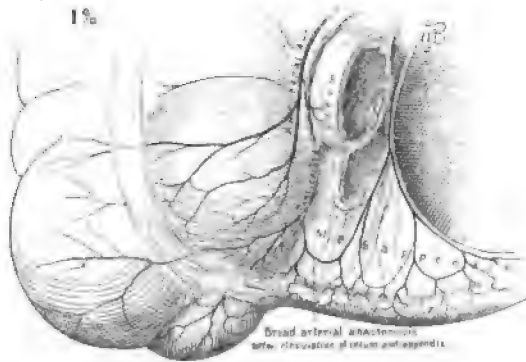


FIG. 116.—BROAD ARTERIAL ANASTOMOSIS IN THE MESAPPENDIX (1 per cent.).

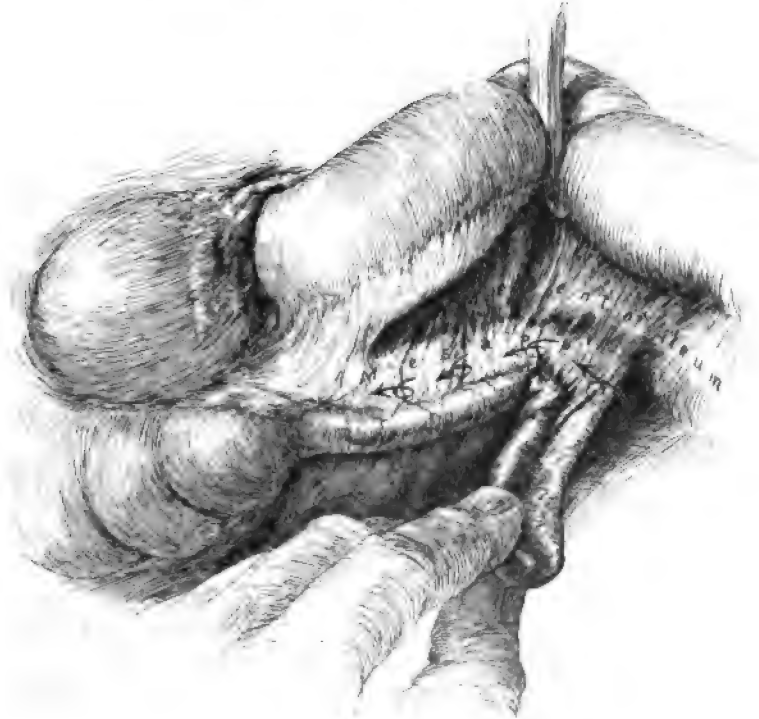


FIG. 117.—SHOWING THE METHOD OF CONTROLLING THE CIRCULATION WHEN THE MESAPPENDIX IS BOUND DOWN.
The ligatures must here control the individual vessels close to the appendix.

not; second, a method which has been frequently practised (see Fig. 119), namely, that of ligating, amputating, and burying the little stump by means of sero-serous sutures. This proceeding has in more than one instance been the source of serious post-operative sequelæ.

The earliest methods of treating the appendix are now obsolete, and no one to-day would think of trimming off and closing the rough edges of a perforation, as in 1887, or even of simple ligation and excision without sterilization, as in 1888.

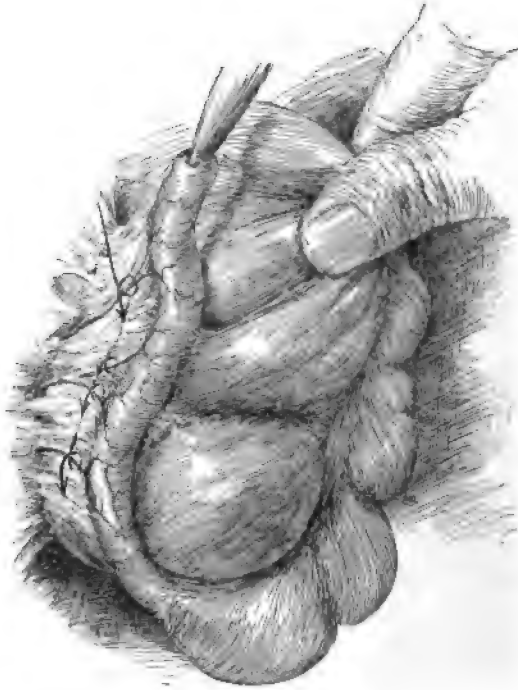


FIG. 118.—SHOWING THE CONTROL OF THE VESSELS IN THE CASE OF AN APPENDIX ADHERENT TO THE OUTER SURFACE OF THE COLON.

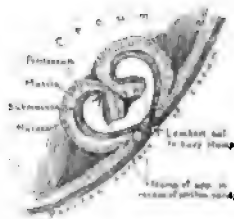


FIG. 119.—A diagram, after Edebohl, to show the danger of burying the exposed mucous membrane of the stump bottled up in a recess of the peritoneal cavity.

A number of improved methods for removal of the appendix in simple uncomplicated cases are now in use. These typical operations, however different in detail, may be classified into the following groups:

1. Ligation, excision, and sterilization with projection of stump.
2. Ligation, excision, and sterilization with depression of stump.
3. Inversion of stump.
4. Inversion of the entire unopened appendix.
5. Amputation flush with the cæcum.
6. Amputation by means of the cautery.

A simple, satisfactory method of removing the appendix is that represented in Figs. 120 to 123. In these figures the mesappendix is tied off down to the angle. A circular suture of silk or chromicized catgut is then laid in the cæcum near the base of the appendix, transfixing the mesentery

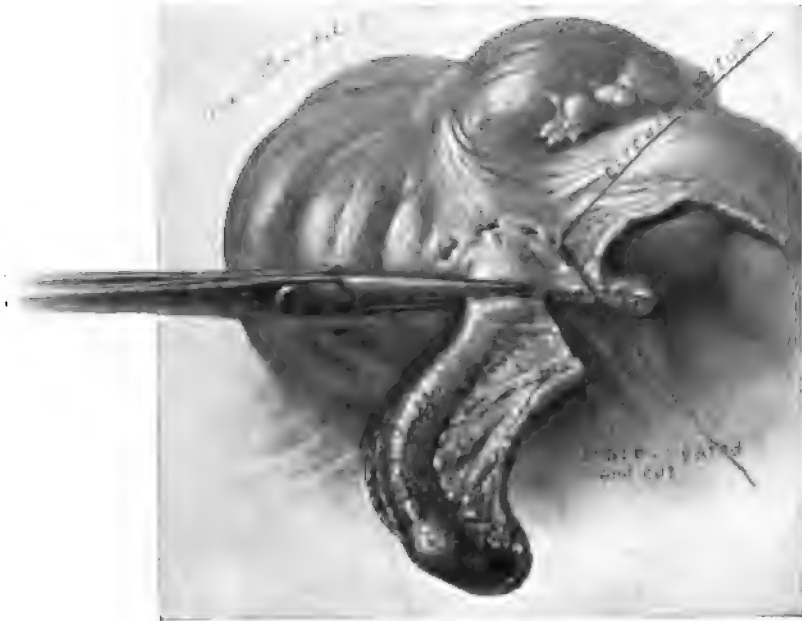


FIG. 120.—1, A SIMPLE, WIDELY-USED METHOD OF EXSECTION OF THE APPENDIX. The mesentery is tied off, a circular suture placed, and the appendix clamped.



FIG. 121.—2, THE STUMP OF THE APPENDIX IS THEN GRASPED WITH FORCEPS AND THRUST INTO THE BOWEL.

if necessary. The appendix is then grasped with forceps and amputated, about 1 cm. from the cæcum. The cautery may be used in making the amputation. If the knife is used, the end of the stump should be sterilized with carbolic acid. The stump is then grasped with a pair of forceps (see Fig. 121) and pushed into the cæcum as the circular suture is tied (Fig. 122).

The wound area is then buried under two or three mattress sutures and the mesenterium covered in by a continuous fine silk suture (Fig. 123).

In order to render the appendix perfectly pliable at the point of ampu-



FIG. 122.—3, AT THE SAME TIME THE CIRCULAR SUTURE IS TIGHTENED AND TIED, AFTER WHICH THE FORCEPS IS WITHDRAWN.

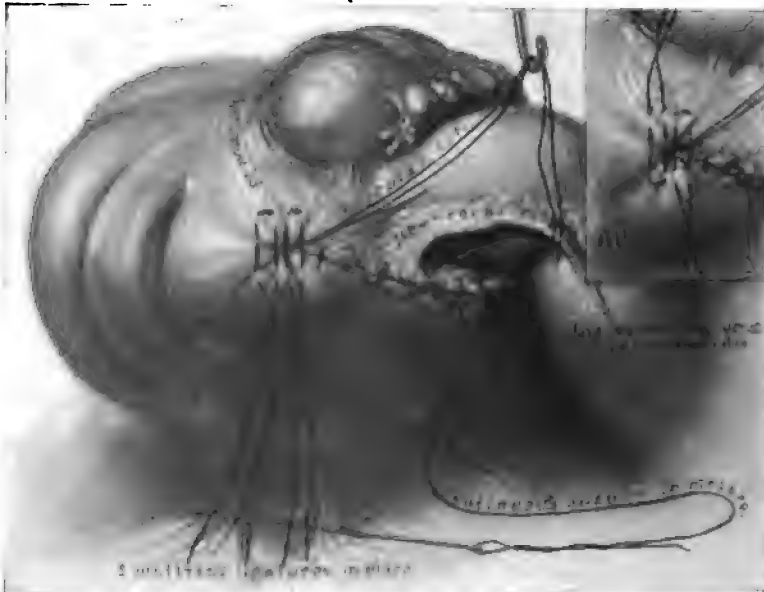


FIG. 123.—4, FINAL STEP SHOWING THE PLACING OF THE MATTRESS SUTURES OVER THE CIRCULAR SUTURE.

tation, FINNEY uses the plan of crushing it near the base with a pair of forceps and then working the forceps up and down so as to free the interior of the appendix of its mucosa. This plan produces a narrow strip of tissue which may be ligated and inverted into the cæcum while a circular suture

is tied. C. W. BARRETT (*Ann. Surg.*, 1908, Vol. 47, p. 246) has recently introduced a method of placing the constricting ligature at the base of the appendix, in the tissues of that organ, just external to the mucous membrane. The needle carrying the thread is passed in at one side of the appendix, the point skirting the mucous membrane, and out at the opposite side. It is reintroduced at the same point, passed about the opposite half



FIG. 124.—HALSTED'S THREE-CLAMP METHOD OF REMOVAL. FIRST STEP.

The circular suture is placed as shown; the three clamps are then applied, the middle one first.

of the mucous membrane, and brought out at the original point of entrance. After the appendix has been crushed with forceps and amputated, it is inverted by means of a two-pronged tucker, similar to that used for packing gauze through a uterine speculum. Then the running string is drawn tight and the operation completed by a Lembert continuous stitch to the peritoneum.

Another method, constantly used in the surgical department of the Johns Hopkins Hospital, is that of the three clamps; applied as shown in

Figs. 124 and 125; first the middle clamp, then the one above, and then the one below. Upon removing the middle clamp, a narrow strip of compressed tissue is exposed for amputation with knife or cautery.

G. R. FOWLER'S CIRCULAR FLAP METHOD (*Treatise on Appendicitis*, 1894, p. 162). A temporary ligature is thrown around the base of the appendix close to the cæcum and twisted until it constricts the organ sufficiently to prevent the escape of fecal matter. A second ligature is applied about half an inch from the first and tied. A circular incision, including the serous coat and the subserous connective tissue, is now made in the space between the two ligatures (Fig. 126). A cuff-shaped flap formed of these structures is turned back toward the temporary ligature,



FIG. 125.—HALSTED'S THREE-CLAMP METHOD, SECOND STEP.

The middle clamp is removed, the ribbon burned through with the cautery, and the stump inverted. The knife may be used in place of the cautery, taking care to sterilize the end of the stump with carbolic acid.

and another ligature of fine ordinary catgut (which has not been hardened) is placed around the wall of the appendix at the bottom of the reflected cuff of serosa and within it. This ligature is tied tightly, and cut off close to the knot (Fig. 127). The appendix is now amputated, and the mucous membrane of the stump touched with the thermocautery or with fuming nitric acid. The cuff-shaped flap is next placed over the face of the stump, which is then grasped by a pair of dissecting forceps and crowded against the wall of the cæcum in such a manner as to form a furrow or depression in it (Fig. 128). The edges of the cæcum are sutured over the stump of the appendix by means of a double row of Lembert sutures, so disposed that the stump is buried out of sight. In two or three days the ligature about the wall of the appendix gives way, but in the meanwhile the sutured edges of the furrow have become strongly adherent, so that there is no danger of escape of the contents of the intestines.

The electrothermic angiotribe has been successfully used by A. J. C. SKENE, and is advocated by him (*N. Y. Med. Jour.*, March, 1888), and more recently by A. J. DOWNES ("Vermiform Appendix and its Diseases," p. 567).



FIG. 126.—FOWLER'S CUFF METHOD. FIRST STEP.

Mesappendix divided; a temporary ligature at the base and a ligature beyond to close the appendix. A circular incision between the ligatures dividing only the outer coats.

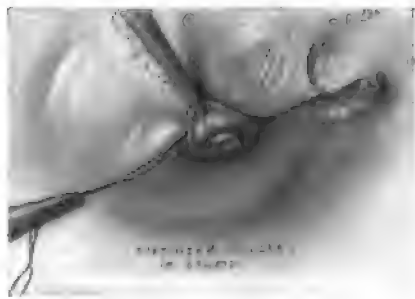
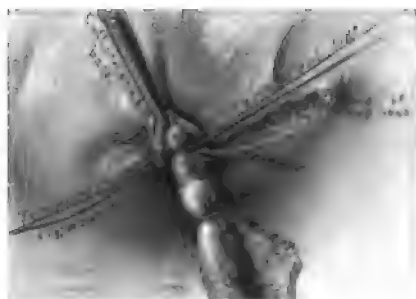


FIG. 127.—FOWLER'S METHOD, SECOND AND THIRD STEPS.

First figure, the cuff stripped back, a ligature applied at the base, and the appendix removed close to ligature at arrow. Second figure, short stump sterilized.

KELLY'S METHOD.—My own method is that of crushing the base of the appendix with a pair of powerful forceps (see Fig. 129), and then slowly amputating it with the Paquelin cautery at a bright red heat,

taking from forty-five to sixty seconds in the process. The distal end of the appendix should be clamped to prevent the escape of its contents (Fig. 130). By keeping the cautery in close contact with the forceps, which is bevelled for this purpose, the latter is converted into a heating iron, and thoroughly cooks the little stump, firmly sealing it, and converting it into a translucent ribbon of tissue, after which it is invaginated into the cæcum (Fig. 131) and the circular suture drawn up covering the wound



FIG. 128.—FOWLER'S METHOD, FOURTH STEP.
Closure of cuff over stump.

area (Fig. 132). It is safer to add a row of sero-serous mattress sutures over this. If there is any traction on the appendix in the operation through a median incision, it is well to place the purse-string suture as shown in Fig. 131, before clamping and cauterizing. The suture should be placed well away from the stump. The entire procedure of removing the appendix may be accomplished in from five to seven minutes.

Atypical Operations for Removal of the Appendix.—**ADHESIONS.**—In a case of appendicitis complicated by adhesions it is of the utmost importance to avoid injury to the coats of the adherent intestines. One of the

simplest complications is that of omental adhesions, in which the diseased part of the appendix is not infrequently found enveloped in the free border of the omentum, which acts as a protecting barrier, effectively limiting

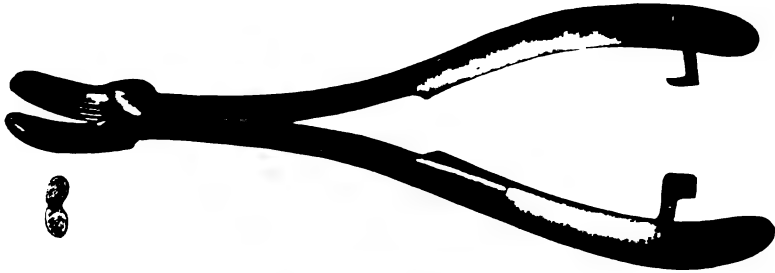


FIG. 129.—KELLY. CRUSHING FORCEPS, HALF NATURAL SIZE, WITH GROOVE FOR CONTACT WITH CAUTERY POINT FOR COOKING THE STUMP AND CONVERTING IT INTO A TRANSLUCENT BAND.



FIG. 130.—KELLY'S METHOD. 1. THE MESAPPENDIX IS LIGATED AND DIVIDED. A CIRCULAR SUTURE OR MATTRESS SUTURE IS THEN PLACED READY TO TURN IN THE STUMP. THE APPENDIX IS THEN CRUSHED NEAR ITS BASE WITH POWERFUL GROOVED FORCEPS AND HELD AWAY FROM THE CÆCUM BY THE WET GAUZE. IT IS THEN SLOWLY AMPUTATED WITH THE CAUTERY.

the spread of the disease. In all such instances the safest plan is to remove the omentum with the appendix by excising as large a piece as may be necessary and then amputating the appendix as it lies undisturbed in its omental blanket.

One of the simplest forms of adhesions, which is also one representing a conservative effort on the part of nature to shut off the peccant organ,



FIG. 131.—2. THE LITTLE TRANSLUCENT STUMP IS THEN SIMPLY INVAGINATED INTO THE CÆCUM BY THE CIRCULAR SUTURE.

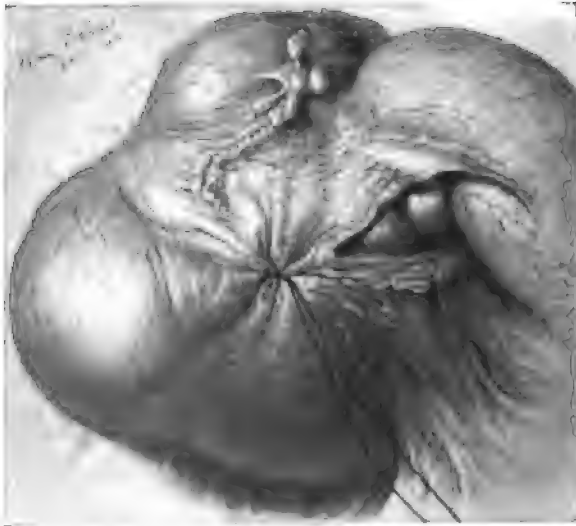


FIG. 132.—3. THE OPERATION COMPLETED.

is the formation of a net of adhesions uniting the ileum to the caecum, and pocketing the diseased appendix below (see

Fig. 133). In the removal of such an appendix it is only necessary to pack off on all sides with great care and then to cut through the tent wall and to liberate and excise the organ.

When the diseased appendix is densely adherent in its distal portion it is a good plan to expose its base and then detach it in such a manner as to free the appendix from the cæcum. The distal freed portion is then wrapped in a piece of gauze for protection, while the opening into the bowel is closed by whatever method the operator prefers. After this has been done, the



FIG. 133.—SHOWING THE ENLARGED INFLAMED APPENDIX 5.5 CM. LONG, 1.5 CM. THICK, COMPLETELY HIDDEN AWAY BY NEWLY FORMED ADHESIONS UNITING THE ILEUM TO THE BASE OF THE CÆCUM IN THE ILEOCÆCAL ANGLE, THUS FORMING A TENT COMPLETELY SHUTTING IN THE DISEASE.

Recurrent appendicitis. B., æt. thirty-two, Feb. 15, 1902. Recovery.

adherent end of the appendix can be dissected out of its bed with far greater facility than was possible when both extremities were anchored, the one to the cæcum and the other by the adhesions; the precaution of surrounding the matted mass on all sides with gauze before handling it and so risking the rupture of an abscess, must never be omitted. This plan is especially suited to the gynecologic field. The danger attending too great traction on the bowel in the effort to reach a deep-lying appendix is illustrated by a case reported to me by DR. A. M. POND of Webster City, Iowa. Here, in trying to reach a mass of exudate behind the cæcum in a case of perforated appendix, the mesentery of the gut was torn from its attachment

for ten inches and there was free hemorrhage. The rent was sutured, as the condition of the patient did not permit a resection of the bowel.

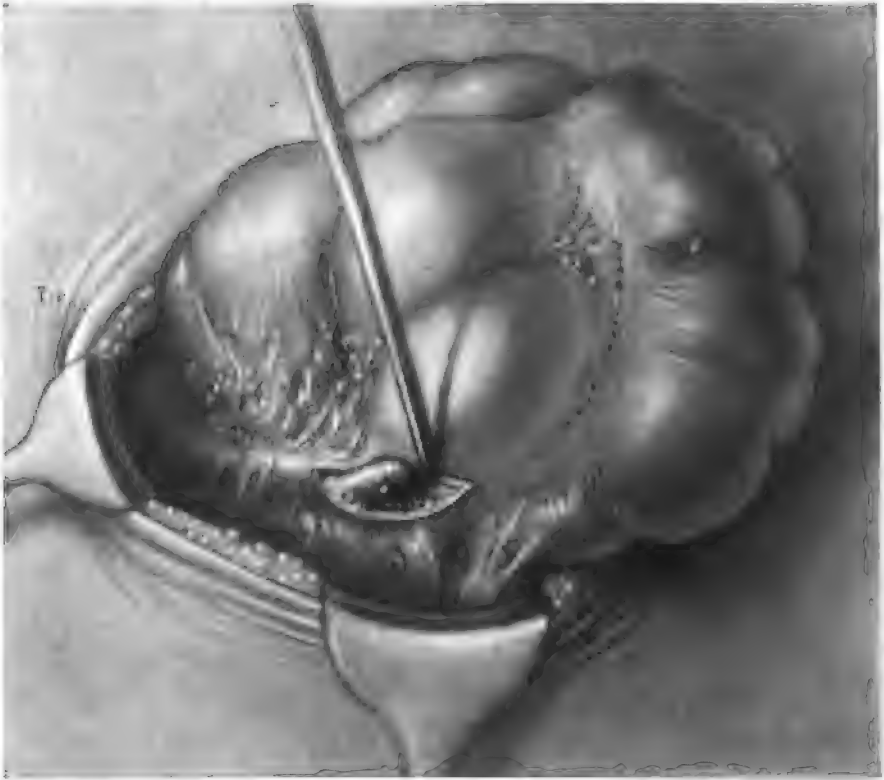


FIG. 134.—H. A. KELLY. 1. SHOWING THE METHOD OF STRIPPING OUT THE MUCOSA AND SUBMUCOSA IN THE CASE OF A DENSELY ADHERENT APPENDIX.

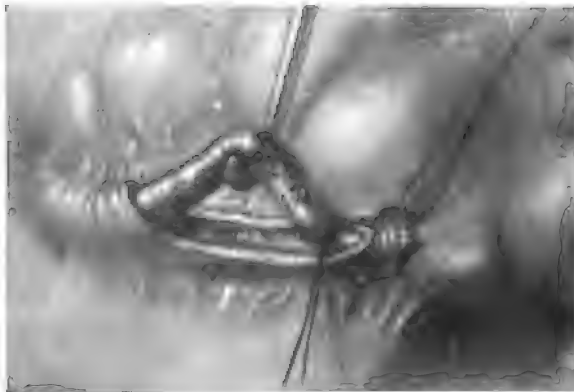


FIG. 135.—H. A. KELLY. 2. THE INCISION IS CONTINUED A SHORT DISTANCE DOWN THE APPENDIX WHICH IS FURTHER LIFTED OUT OF ITS SEROSA AND MUSCULAR COATS, AS SHOWN.

When the whole appendix lies imbedded in strong old adhesions, and can be removed only by digging it

out of its bed, there is considerable risk of tearing the adjacent structures, or of exciting hemorrhage by rupturing one of the numerous small vessels, which, being situated in the midst of the matted tissues, are difficult to control. In all such cases it is a good plan to detach the base of the appen-



FIG. 136.—H. A. KELLY. 3. THE REMAINDER OF THE APPENDIX CAN THEN OFTEN BE WITHDRAWN BY SIMPLE TRACTION.

dix as just described (or as shown in Figs. 134 and 135), and then, catching the freed end with a pair of artery forceps, to lift it up and circumcise the organ just below the forceps by cutting through the peritoneal and onto the muscular coats. A longitudinal incision, including only these coats, is then carried down to the dorsum of the appendix as far as it is visible, after which the appendix can be stripped out of its bed (see Figs. 136 and

137) by traction in the direction of the tip, or it can sometimes be delivered by a straight pull. If it begins to break, it must be grasped afresh with the forceps lower down and the stripping process resumed. In this way the entire serosa with a portion of the circular muscular coat is left behind. There is often no bleeding at all, and even if there is, it is more easily controlled than when the appendix has been dissected out. This is a dangerous method if the appendix contains pus in its distal portion. WALSHAM (*Treatise on Appendicitis*, 1901, p. 25) advises that when the appendix is so adherent to important structures that the whole of it cannot be removed, it should be divided near its cæcal attachment, the proximal end closed in the usual manner, and as much of the organ removed as safety will permit, either by dissection or by shelling out from the peritoneal cavity.



FIG. 137.—H. A. KELLY. WHEN THE APPENDIX DOES NOT ESCAPE READILY ITS DORSUM MAY BE INCISED DOWN TO THE TIP, WHEN BY TRACTION, AS SHOWN, THE INNER COATS ARE REMOVED FROM THEIR MUSCULAR BED.

In cases where the end of the appendix enters a small abscess cavity and is surrounded by adherent intestines which cannot be stripped off with safety, I employ the following method: After freeing the base of the appendix from the cæcum, I trace the appendix upward until it enters the abscess cavity, as, for example, under the ascending colon, where the separation of adhesions cannot be effected without injuring the coats of the bowel. I then pack off the field of operation from the surrounding peritoneum on all sides, and after dividing the appendix at its base with a pair of forceps, proceed to split it open all the way to the tip, using the blade of a pair of open scissors or a grooved director as a guide. It is thus possible to penetrate the abscess cavity, to open and to cleanse it, without doing any damage to the colon. In one case of this kind I followed the cleansing of the cavity by drainage, and the patient made an uninterrupted recovery. Whenever possible in these or similar cases (see Figs. 138, 139, 140, and 141), the mucosa and submucosa of the appendix should be removed by dissection or by scraping. Drainage should always be used.

When the appendix is lost in a mass of adhesions surrounding the head of the caecum, and careful efforts to release and expose it are unavailing, the best plan, especially if the operator becomes uncertain as to his landmarks, is to approach the mass in an entirely new direction, namely, from above and behind the caecum, as recommended by W. H. CARMALT (*Yale Med. Jour.*, Jan., 1896).



FIG. 138.—1. SHOWING A RETROCOLIC APPENDIX SO BURIED IN A BED OF ADHESIONS THAT REMOVAL IN THE USUAL MANNER IS FRAUGHT WITH DANGER TO THE COATS OF THE CÆCUM.

A remarkable and, I think, unique case is that of FINNEY, shown in Fig. 142, in which a retrocolic appendix was not only situated behind the peritoneum but actually lay with its tip plunged into the substance of the psoas muscle. (See p. 315.)

When the appendix is held down by a short mesentery, or when the mesentery is absent, especially in

cases where the appendix extends high up behind the cæcum, it is best to detach it at the root and then extirpate it by pushing the colon gently to the median line, rather than by dragging on the appendix itself and thus risking rupture of its vessels. A case of this kind in which the appendix was tightly adherent to the cæcum occurred in the practice of DELANO KIRCHER, and was excised by him without ligatures.

When the omentum is attached firmly to one part of the appendix, the safest plan is to tie the omentum and

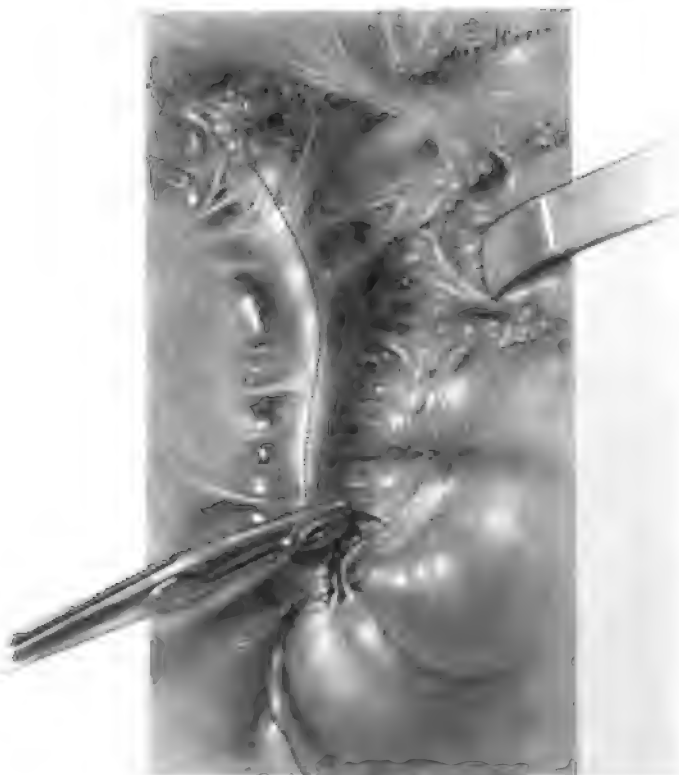


FIG. 139.—2. H. A. KELLY'S METHOD OF DEALING WITH SUCH AN APPENDIX BY DETACHING THE BASE FIRST AND CLOSING THE CÆCUM. IF IT IS THEN IMPOSSIBLE TO FREE ANY PORTION OF THE ORGAN FROM ADHESIONS WITHOUT GREAT RISK TO THE COATS OF THE COLON, IT MAY BE SPLIT OPEN AS SHOWN IN DOTTED LINE.

separate it, so that the part attached to the appendix is removed with that organ. This is particularly necessary because the omentum, when attached in this manner, sometimes encapsulates a small abscess or contains the point of perforation. When on opening the abdomen the omentum is found adherent in the iliac fossa or about the head of the cæcum, it should be detached with the utmost care a little at a time and under the closest inspection. When the omentum is adherent to the appendix or wrapped around it, it is safe to presume that there has been a perforation of the appendix, and that the omentum envelops an abscess, which is ready to distribute its contents over the peritoneum the moment the barrier is

removed. There are two forms of omental adhesions to the appendix, namely, a knuckle adhesion or an adhesion of the free border directly against the inflamed organ; and an enveloping of the appendix in the border of omentum, which is wrapped around the extremity of the appendix. The omentum often under these circumstances saves the life of the patient, by grasping the appendix with its infectious materials, in such a manner as to prevent extravasation, especially when the disease is situated in the outer portion of a free appendix.

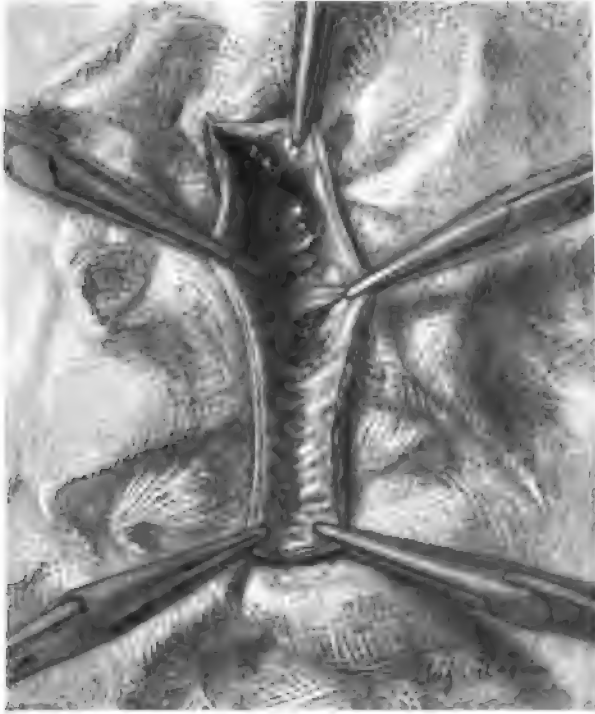


FIG. 140.—3. H. A. KELLY'S METHOD. AFTER ISOLATING THE APPENDIX WITH GAUZE, ITS EXPOSED MUCOUS SURFACE AND ANY ABSCESS NEAR THE TIP ARE CAREFULLY CLEANSED AND THOROUGHLY CAUTERIZED.

When the appendix is so concealed that it cannot readily be identified, it is important to utilize the various landmarks and to investigate the cæcum minutely on all sides in order to find its base, if possible, or at least some other portion. If this is not done, and the operator simply attempts to enucleate a mass somewhere in the region of the appendix, he may be betrayed into such an unfortunate mistake as was made by N. P. DANDRIDGE (*Ann. Surg.*, 1903, vol. 38, p. 367), which he has reported with commendable frankness in order that others may profit by his experience. In this case, which was that of a man twenty-six years old, an incision was made at the outer margin of the rectus, and, as the appendix could not be found, a mass lying beneath the peritoneum, to the inner side of the colon and above the ileocæcal valve, was thought to be an exudation

around it. This exudate was freed with the finger, and a pulsating vessel of some size, which passed through it, was ligated. On removal, the parts proved to be a mass of enlarged glands about the size of a hen's egg, which the microscope showed were not tuberculous. The thickened and club-shaped appendix was found behind the cæcum and removed. The wound, which was completely closed, broke down after the eighth day, fecal matter escaped, and afterward about 15 inches of small intestine and cæcum sloughed away. This injury was repaired after four intestinal operations.

When the appendix is distended and seems ready to burst, unless it can be lifted and tied off with ease, it is safer, after isolating it with gauze pads, to aspirate it, withdrawing all fluid, and perhaps following this by injecting into it pure carbolic acid. Never straighten or pull on a distended appendix. Clamp the mesappendix step by step to its base and then clamp off the base and divide with the cautery.

Retrocæcal Appendicitis.—The fact that a retrocæcal position of the appendix demands special consideration, and may mislead the operator who is not upon his guard, was first noticed, to the best of my knowledge, by C. B. NANCREDE, of Ann Arbor, Michigan (*Med. News*, 1888, vol. 52, p. 570). Recent investigations show that the retrocæcal position occurs more frequently than was formerly supposed. MONKS and BLAKE found that the appendix was behind the cæcum in over 17 per cent. of all cases (*Reports Bost. City Hosp.*, 1903); BYRON ROBINSON found it so situated in 20 per cent. in men and in 35 per cent. in women (*Ann. Surg.*, 1901, vol. 33, p. 407); while statistics from the Johns Hopkins Hospital give the retrocæcal position as present in 20 to 30 per cent. of all cases (Chap. II).

It often becomes necessary, therefore, to treat cases of appendicitis in which the appendix must be sought behind the cæcum. Several instances

of this kind which have recently come under my observation induced me to hope that it would be possible to find in retrocæcal appendicitis such a characteristic syndrome of symptoms as would clearly define this interesting and important group of cases at the bedside. If we could, with a fair degree of certainty, predict in a large percentage of cases that the appendix and the abscess were to be found in a retrocæcal position, such knowledge would be of material aid to the surgeon in guiding his exploration. If, for example, he knew that the appendix lay behind the cæcum,

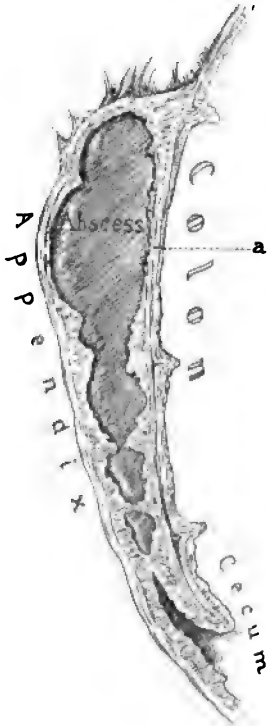


FIG. 141. — 4. SHOWS SUCH AN ADHERENT APPENDIX IN SECTION, WHOSE WALLS ARE FUSED WITH THE CÆCUM AND COLON.

The object of the incision, cauterization, and drainage is to leave the coats of the appendix as a protecting barrier to the colic wall (a). As much of the mucosa and inner wall should be dissected as possible. (See p. 310.)

he would often seek to conduct the operation extra-peritoneally, lifting up the peritoneum, much as is done in tying the common iliac artery; and he would in many instances make his external incision at a point higher up, above the crest of the ilium (Edebohls's incision, see Fig. 102, h);



FIG. 142.—FINNEY'S CASE IN WHICH THE APPENDIX LAY RETRO-PERITONEALLY AND THE TIP, OF THE SIZE OF AN ALMOND, CONTAINING A CONCRETION, LAY BURIED IN THE SUBSTANCE OF THE PSOAS MUSCLE, AS SHOWN IN THE RIGHT-HAND FIGURE. U. P. I., April 18, 1899. (See p. 311.)

and with the colon once exposed he would with greater precision seek for the appendix, which has not infrequently been abandoned and recorded as "not found" in cases belonging to this very group.

My investigation of this point has covered the histories of 90 patients in whom the appendix occupied the retrocæcal position; 40 of which were

gathered from general medical literature, and 50 from the records of the Johns Hopkins Hospital, all of the latter with two exceptions occurring in my own clinic, being from the service of my colleague Prof. W. S. HALSTED.

In order to determine any special characteristics which might mark this group the following points were determined: (1) The seat of pain; (2) the seat of swelling, and its form; (3) adduction of the right thigh; (4) the presence of blood and mucus in the stools.

The pain was located in the right iliac fossa in 65 of the 90 cases. In 6 of the 40 cases collected from literature it was present in the right loin, but it was not noted as so found in any of the others.

The seat of the swelling, whenever stated, was in the right iliac fossa, and in both my own cases, as well as in some others, it was noted as extending backward toward the loin. It is frequently noted that the swelling was ill defined.

Abduction of the thigh is only noted in a few cases, and the same is to be said of blood and mucus in the stools, which appear as a note in the history but 5 times in all.

In 60 out of the 90 cases previous attacks are noted to have occurred.

It is manifest that no special group of symptoms can be constructed from these facts. I believe, however, that there is a tendency on the part of the abscess to extend upward, behind the cæcum and out toward the iliac brim, forming an elongated swelling high up. In cases where this occurs we may reasonably expect that the appendix will be found behind the cæcum, and make a corresponding incision in the loin, working back toward the retrocæcal region in the endeavor to expose the affected area.

The matter has not as yet been borne specially in mind by surgeons, and I venture to hope that closer attention will reveal some differential points of value, which may enable us to subdivide this difficult subject and thus simplify the treatment of at least one group of obscure cases. I myself have had two cases, the records of which will be found in my monograph, page 580.

There is a well-defined group of cases, where the appendix lies back of the cæcum and the ascending colon, in which a small pus cavity forms somewhere near the tip of the appendix and continues to cause exacerbations in the symptoms from time to time. The appendix is always embedded in a mass of inflammatory tissue and plastered into the walls of the cæcum so firmly that it is impossible to separate it without injury to the larger bowel. The abscess may be an old one, with thickened, inspissated pus, or it may contain a few cubic centimetres of pure pus, and sometimes a concretion is found lying outside the appendix.

Whenever the induration or area of fluctuation extends upward and backward toward the loin, having an elongate, ovoid, or sausage shape, it is better to make the incision correspondingly over the iliac brim, and even to extend it around the side somewhat posteriorly. After cutting through the skin, in a direction from above obliquely downward, the oblique muscles are best separated by a blunt dissection in the direction of their

fibres; the transversalis is pierced with the blunt end of an artery forceps, and the abscess cavity opened. If more room is desired for drainage, the muscle fibres of the internal oblique may then be carefully incised, avoiding the injury of any nerve trunk. The advantage of an incision in this locality lies manifestly in its dependent position for drainage, when the patient lies recumbent or turned somewhat to the right side. If the abscess is a long or a large one, a counter-opening may be made below, over the iliac fossa, so as to facilitate the cleansing by through-and-through irrigation.

Disease in the Neighborhood of the Appendix. — The surgeon should never be content to discover and remove a diseased appendix only; he



FIG. 143.—1. CHRISTIAN FENGER'S CASE OF APPENDIX DENSELY ADHERENT TO CAPUT COLI AND ILEUM.

ought always to explore the parts within reach in order to discover any evidence of further disease. All dead tissue should be removed. First, he should investigate the condition of the cæcum, for sometimes there is an evident involvement of that portion of its base surrounding the insertion of the appendix, and occasionally isolated ulcers may be found at some point in the caput coli, when they should be excised.

Figs. 143 and 144 illustrate the method of excision to be used when the disease is located in the neighborhood of the appendix or surrounds the cæcal orifice of the appendix, as in a case reported by C. FENGER (*Amer. Jour. Obst.*, 1893, p. 194).

The patient, a man of thirty-two. Two typical attacks of appendicitis previously, the second followed a month later by an abscess which was incised, leaving a fistula in right lumbar region still open when he consulted Fenger a year later. The whole right side

was then occupied by a board-like swelling, covered with dilated veins in lumbar region, while below the twelfth rib was a fistulous opening. A large abscess was opened by an incision leading from Petit's triangle, downward and forward toward crest of ilium, cutting through skin, oblique muscles, and a layer of hard, white, connective tissue, half an inch thick. From this cavity opened a sinus found to run down the iliac fossa, and extend downward to four inches below Poupart's ligament along the line of the femoral vessels. In an upward direction the sinus extended under ribs and liver, as well as backward four inches toward vertebral column. Cavities were curetted and granulation lining removed. During irrigation of upper cavity an unusually large fecal stone, an inch and a quarter long and a quarter of an inch wide, was washed out. Two drainage tubes were passed in opposite directions, and the cavity filled with iodoform gauze. A month later a second fecal stone was washed out, and in another month the cavity had closed.



FIG. 144.—2. FENGER'S CASE SHOWING ABOVE THE THICKENED TIP, AND BELOW THE PERFORATION NEAR THE BASE.

The middle figure shows the perforation and the area of tissue excised, including both perforation and base of the appendix. The opening was closed by a continuous suture in the mucosa (x), a row of Lembert sutures (y) including serosa and muscularis, and over this a serous suture burying the whole.

Another group of cases in which the large bowel is more or less involved is that of a tuberculous process involving the caecum (ileocaecal tumor) in its early stages; and in such instances, if the attention of the operator is directed to the diseased appendix alone, he may amputate this, and then have the annoyance of seeing a permanent fecal fistula remain, while the disease in the iliac fossa advances. RICHARDSON (*N. Y. Med. Jour.*, July, 1901), in speaking of cases where he has been called on to operate for permanent fistula following operation for appendi-

citis, says: "In several of these patients it was necessary to resect a large portion of the cæcum, for the tubercular process had invaded all the layers, and had caused extensive ulceration of the mucous membrane."

FISTULA.—Fistula occurs in connection with disease of the appendix under one of two conditions, namely:

1. As a sequela to appendicitis. These cases are considered in Chapter XX, p. 380.

2. As a complication of chronic appendicitis. In these cases the treatment is concerned with the removal of the appendix as well as with the cure of the fistula, and they will, therefore, be considered here.

In operations where there is an indurated, suppurating area, with a fistulous opening onto the exterior, the important question is how far to carry the operation. In other words: shall an effort be

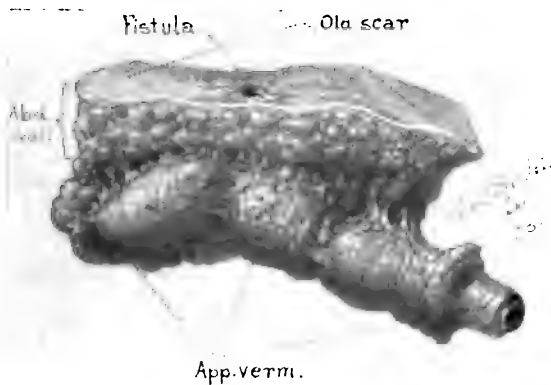


FIG. 145.—CASE OF VAN COTT'S. FISTULA FROM AN APPENDIX ONTO SURFACE OF ABDOMEN.
The operation consisted in excising scar with fistula in appendix *en masse*.

made to remove the fistulous tract and the appendix together; or shall the treatment at first consist simply in a free incision with curettage, and the establishment of direct and thorough drainage?

The excision of the entire area with the appendix as shown in Fig. 145 is the ideal procedure, but it is not always safe. It is best adapted to those cases in which the fistulous tract is well defined and contracted, leading directly into the diseased appendix. A good illustration of this class of cases is one reported by VAN COTT ("Vermiform Appendix and its Diseases," p. 592).

OBLITERATION OF THE LUMEN OF THE APPENDIX.—BRYANT has reported a case (*Jour. Amer. Med. Assoc.*, Nov. 3, 1894) in which stricture of the appendix was associated with abscess of the proximal portion, and LAUTARD of Nice, on opening an abscess containing one and a half litres of pus, found the appendix gangrenous at its free extremity, with such dense adhesions to the cæcum through the rest of its extent that it could not be detached without great risk of rupturing the bowel. The abscess cavity at the tip was drained, and in two weeks the lumen was obliterated.

CHAPTER XVIII.

ABSCESS IN THE NEIGHBORHOOD OF THE APPENDIX.

THE term suppurative peri-appendicitis, introduced by TERRIER, includes all cases in which the suppuration is localized in the neighborhood of the appendix, or, in other words, in which there is an iliac, lumbar, pelvic, inter-intestinal, sub-umbilical, or retrocaecal abscess.

The location of an abscess directly connected with the appendix varies according to: the position and the length of the appendix; the situation of the infected area in the appendix, whether in the middle, the base, or the tip; the presence of abnormalities in the position of the cæcum, or of the appendix. An appendix of average length, for example, may lie in the iliac fossa, or it may hang over the pelvic brim into the pelvis, or it may lie under the ileum, or behind or in front of the cæcum to the inside (Fig. 149, p. 323) or outside, or, finally, it may lie underneath the cæcum (Figs. 146 and 147, pp. 321 and 322).

In some cases the presence of a pocket or a peritoneal diverticulum will determine the location of an abscess and limit its extent, as in Fig. 76 (see p. 109), where an acute process in the tip might be shut off by an agglutination of the peritoneal surface at the mouth of the pocket. In some extraordinary instances the appendix may be completely concealed under one or more layers of peritoneal folds with more or less valve-like openings (see Fig. 150, p. 324), in which case anatomic advantages exist for the limitation of a spread of infection.

MIKULICZ has drawn especial attention to the natural barriers in the abdomen (see Fig. 148, p. 322) which tend to limit and also to determine the direction of the spread of any infectious materials. The abdomen, as he has shown, may be divided into a supra-omental and infra-omental space; the supra-omental space being subdivided into a subphrenic and an infrahepatic. The diaphragmatic area is again subdivided into right and left areas by the hepatic ligament. The space below the transverse colon and the omentum is subdivided by the mesentery of the ileum, which follows a generally oblique direction from above on the left, down into the right iliac fossa. The pelvic cavity constitutes the most important subdivision of the lower area. It will at once be seen that an abscess starting below the mesentery will be prone to enter the pelvis and extend into the opposite iliac fossa, while an abscess on the outer side of the colon may readily extend upward into the region of the liver.

If we remove the intestines and study the configuration of the posterior abdominal wall, we find the various depressions shown in Fig. 151 (see

p. 325), constituting niches in the body in which pus is apt to collect, forming well-defined abscesses. There are, in general, three of these niches: the deep pelvic and the right and left abdominal respectively, the latter of which may be subdivided again into iliac below and renal above.

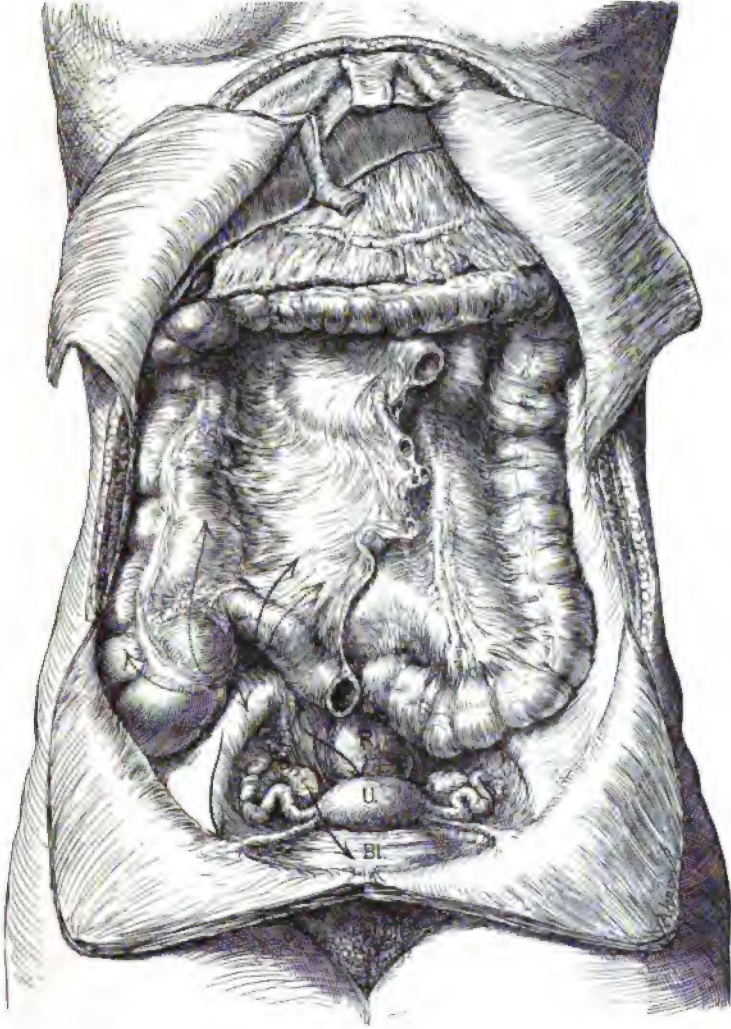


FIG. 146.—A COMPOSITE PICTURE SHOWING THE VARIOUS POSITIONS IN WHICH AN ABSCESS MAY BE FOUND, IN THE PELVIS, BEHIND OR IN FRONT OF THE ILEUM, OR BEHIND THE COLON OR THE CÆCUM.

The location of the abscess, as a rule, is determined by the position of the appendix.

The natural tendency of pus to gravitate upward as the patient lies recumbent will be best understood by consulting Fig. 153, where it is manifest that the posterior abdominal wall is disposed on an inclined plane at an angle of about 30 degrees. The upward course of infection is facilitated not only by gravity, but by the natural drainage of the lymphatics in this direction.

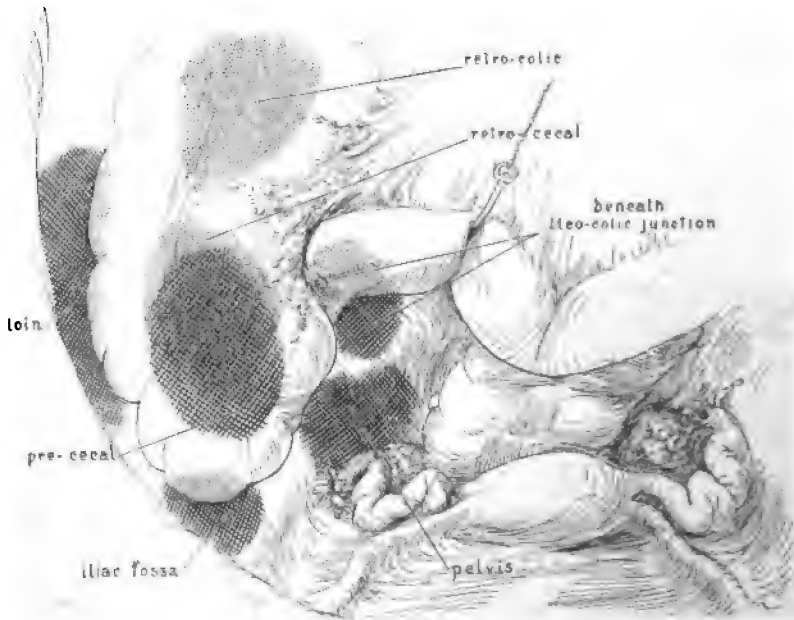


FIG. 147.—THE LOCATION OF VARIOUS SMALL ABSCESSES IN THE ILEOCOLIC REGION. (See p. 320.)

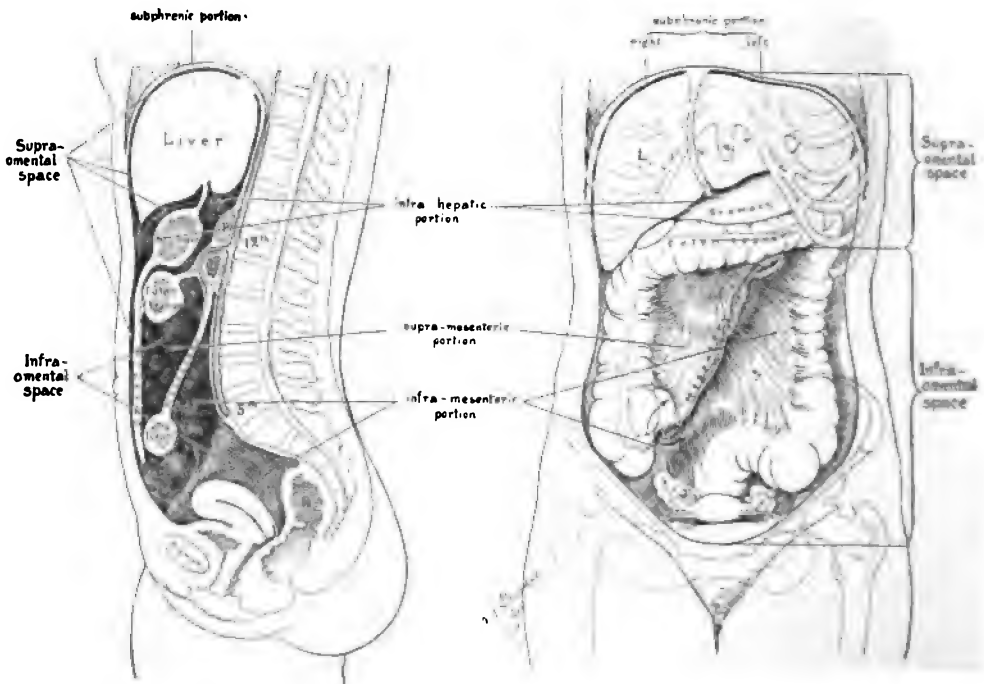


FIG. 148.—MIKULICZ'S BARRIERS TO THE SPREAD OF INFECTION, AIDING IN THE LOCALIZATION OF INFLAMMATORY PRODUCTS. (See p. 320.)

As already said, however, the position of the appendix is of prime importance in determining the direction which pus takes. All appendices which hang in the pelvis drain downward and lead, as a rule, to pelvic abscesses, similar to abscesses arising from the organs which are more uniformly pelvic in position. Furthermore, in addition to the natural barriers, the formation of artificial barriers must be borne in mind. Many cases of appendical abscess have been preceded by previous attacks, which have left adhesions that effectually act as barriers. This



FIG. 149.—SHOWING AN APPENDIX COILED ON ITSELF IN SPIRAL FORM BELOW AND IN FRONT OF THE ILEOCÆCAL JUNCTION.

The ileum is shown lifted up, so as to expose the proximal portion of the appendix. The appendix was bound down by numerous adhesions, passing in every direction, immobilizing the individual coils of the organ. The tip, however, was free and pointed directly forward. The whole organ was intensely inflamed, so much so as to make it impossible to recognize the different coils until the adhesions had been partially severed and removed. The extraordinary spiral form of the appendix resembles, in a remarkable manner, a rattlesnake coiled and ready to spring.

is especially true in cases where the appendix has become embedded in the cæcum. In this class of cases it is no uncommon thing for the pus to break directly into the intestine.

In considering the drainage of an abscess by operation, it is therefore of great importance to know location of abscess, whether in the iliac fossa, whether in the true pelvis or in the renal region, to obtain effectual drainage, as in each of these positions very different incisions and quite different postures have to be employed. The details of this will be considered under treatment of appendical abscess.

Fig. 152 shows the natural tendency of an abscess to pour into the pelvis or to extend up under the layers of the mesileum when the appendix is disposed as represented in the section. It is also evident from this figure that an infection perforating the posterior layers of this fascia is



FIG. 150.—W. W. RUSSELL'S CASE SHOWING THE APPENDIX BURIED UNDER TWO LAYERS OF PERITONEAL FOLDS FORMING TWO POCKETS. (See p. 320.)

The appendix lay flexed on itself in the innermost pocket, as shown in the upper right-hand figure. Gyn. clinic. October 8, 1903. Note that the ileocæcal fold is continuous with the broad ligament.

not only in a position to invade the upper region, as shown in Fig. 153, but to work downward under Poupart's ligament into the thigh.

Removal of the Appendix in Suppurative Cases.—One of the most important questions connected with appendical abscess is the treatment

of the appendix itself. In most cases, especially where there is a large abscess, and the patient is exhausted by the disease, the best plan is simply to lay open the abdominal wall freely so as to drain off the pus, and to pay no attention to the appendix whatever. Treated in this way, the appendix is sometimes discharged as a slough when the dressings are changed, or as the wound is washed out. Or, if the appendix is not seen at any time, it may be so greatly obliterated by the disease and so thoroughly incorporated



FIG. 151.—ABDOMEN SHOWING THREE MAJOR FOSSÆ, RIGHT AND LEFT ABDOMINAL AND PELVIC.

The abdominal fossæ are subdivided into renal and iliac. In these fossæ fluids are prone to accumulate with the patient in a recumbent position. (See Meckel's Diverticulum, Chap. II.)

in the scar tissue of the contracting abscess cavity that it causes no future harm. When the appendix is clearly exposed, or when it lies at some point where it can be reached without risk of opening the peritoneal cavity,—as, for example, along the posterior wall of the fossa, or behind or to the outside of the cæcum or colon,—the surgeon may then cautiously expose the appendix from end to end, amputate and remove it. Not infrequently, however, in such cases, the sutures at the base, closing in the opening into the cæcum, refuse to hold, and the result is a discharge of fecal matter

onto the dressings, lasting for a few days or weeks, and finally disappearing spontaneously; a fecal fistula often follows the simple incision of an abscess, and closes without further trouble after a short interval.

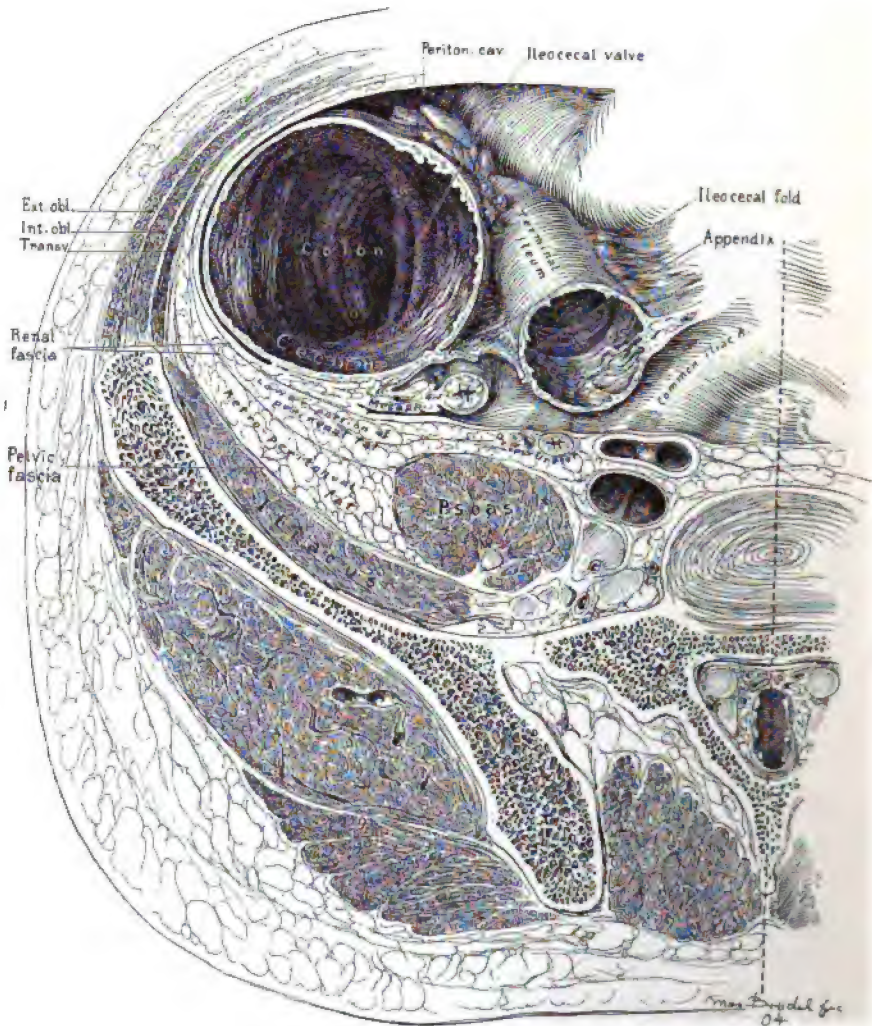


FIG. 152.—HORIZONTAL SECTION JUST ABOVE THE INSERTION OF THE APPENDIX, SHOWING THE RELATIONS OF THE APPENDIX AND THE TISSUES OF THE MESAPPENDIX TO THE FASCIÆ AND MUSCLES OF THE POSTERIOR ABDOMINAL WALL. (See p. 324.)

This figure also demonstrates the method of approaching an abscess about the appendix by an extra-peritoneal route. The section is made in a fat person, and therefore shows the individual layers of the fascia more widely separated than usual.

The alternative plan is that of hunting for the appendix in the abscess cavity or in its walls, even breaking up the adhesions which form the walls of the cavity in the determination to discover and remove the cause of the trouble. While there can be no objection to pulling out a loosened appen-

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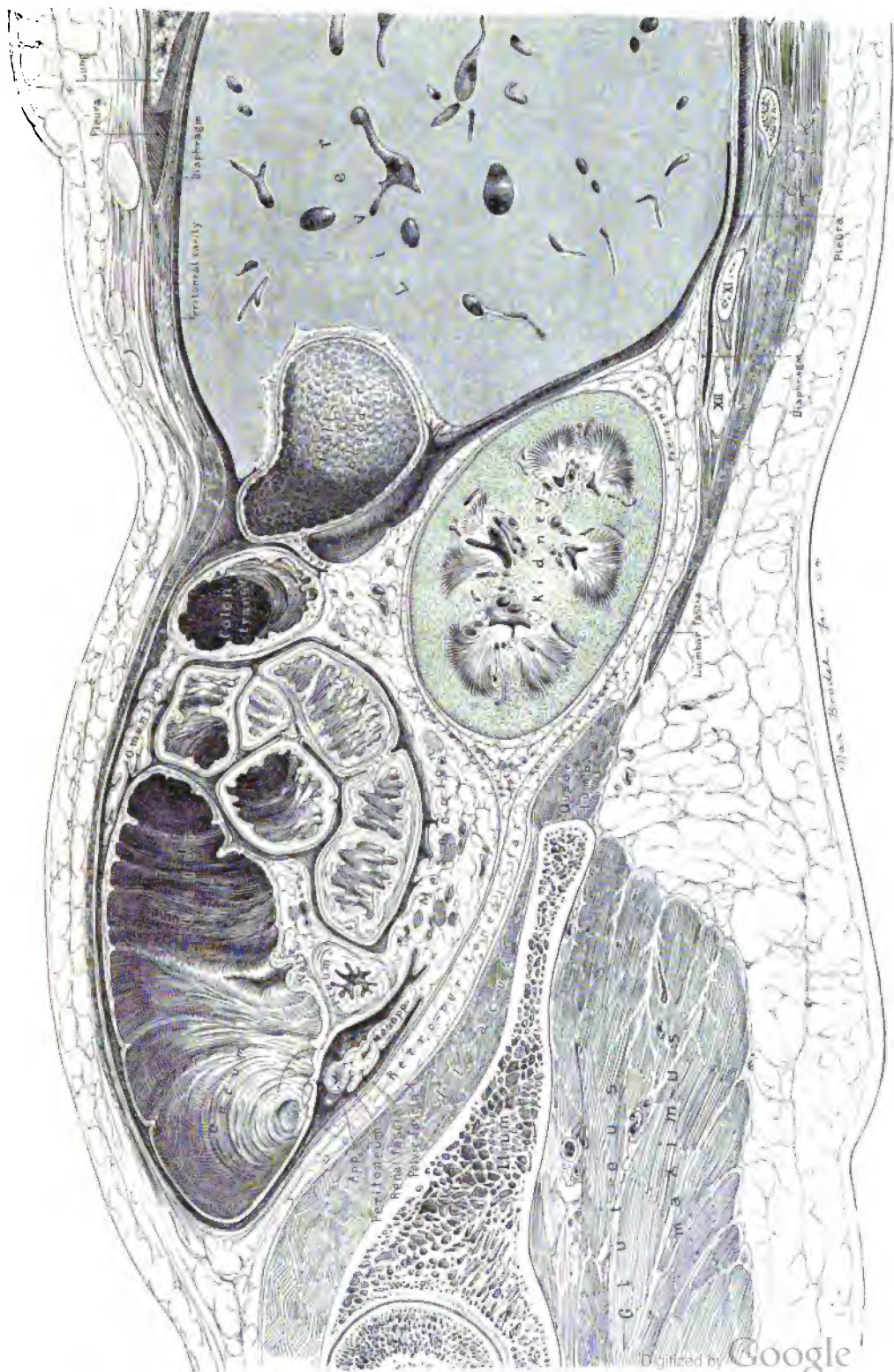


FIG. 153.—FROZEN SECTION (SAGITTAL) THROUGH THE MIDDLE OF POUPART'S LIGAMENT IN THE RIGHT MAMMARY LINE, SHOWING INTERIOR OF CÆCUM AND COLON WITH CÆCAL OPENING INTO APPENDIX AND SECTION OF APPENDIX AND MESAPPENDIX.

The picture shows well the position of the appendix upon an inclined plane formed by the posterior abdominal wall in the recumbent position. Fluid accumulating about the appendix, as may be seen from this section, following gravity, may take one of two courses: either pass in front of the renal fascia and so over and around the kidney to the under surface of the liver, where an infra-hepatic abscess may be formed; or, on the other hand, the fluid may perforate the renal fascia and follow the course of the retro-peritoneal fat behind the kidney up to the diaphragm, where it may penetrate the pleura through a weak space in the fibres of the diaphragm. The peri-renal tissues may be invaded in either of these directions. Gall-bladder cystic.

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dix when it appears sloughing and gangrenous, in common with other sloughing tissues, the practice, once so widely recommended by surgeons, more to be admired for their courage than their discretion, of "always removing the appendix," is to-day pretty generally condemned, although a few excellent members of the profession still continue it.

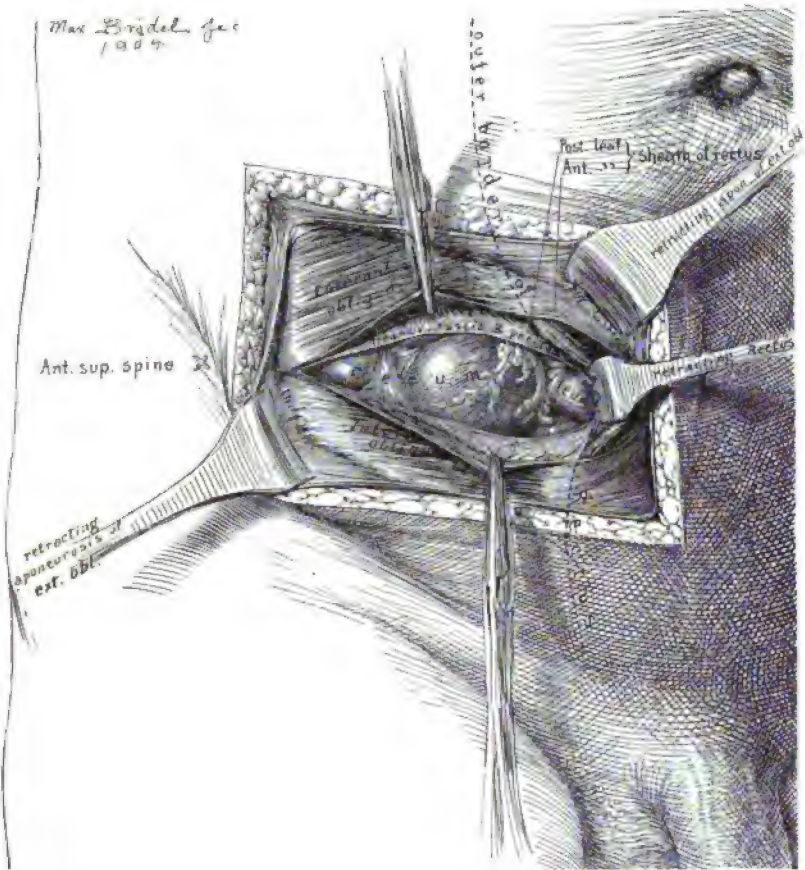


FIG 154.—WEIR'S INCISION FOR THE PURPOSE OF ENLARGING THE MCBURNEY OPENING WITHOUT DIVIDING THE MUSCLES. (See p. 330.)

The skin incision and the separation of the external oblique fibres are made obliquely downward across the semilunar line. The rectus, with the epigastric vessels, is thus exposed and can be retracted. The internal oblique transversalis and posterior lamella of rectus sheath with the peritoneum are then divided, giving abundant room, as shown, for dealing with complications. The figure does not represent the maximum space which can be secured by drawing the transversalis fascia strongly up and down.

It is encouraging to feel assured that when an appendix has gone so far as to produce an abscess in its neighborhood, it is itself, in most instances, so completely disorganized as to occasion no further trouble. The advantage of the simple incision with drainage is well shown by BARLING (*Lancet*, Feb. 22, 1903), who, in a series of 74 abscess cases, removed the appendix in only 25. The remaining 49 cases, where the appendix was left undisturbed, were kept under observation, and in only one case was there a

recurrence of the disease; this one was then operated upon successfully. It is safe to assert that had the surgeon insisted upon finding and removing the appendix in the 49 cases he would have lost a large percentage of them. I must add here, however, that there have been two fatal cases in the Johns Hopkins Hospital from a recurrence of the abscess after simple incision. The balance-sheet, however, may be said to be overwhelmingly in favor of drainage without extirpation, where the latter course presents any serious difficulty or exposes the patient to the dangers of opening the free peritoneum.

JAFFÉ (*Berl. klin. Wochenschr.*, Dec. 14, 1903, p. 1148), out of 100 cases which were opened and drained, saw only 5 in which it was necessary

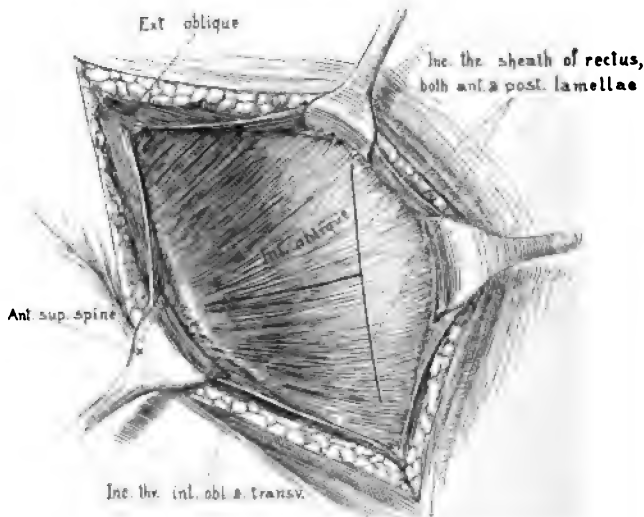


FIG. 155.—DOUGHTY'S METHOD FOR SECURING MORE ROOM IN ABSCESS AND OTHER DIFFICULT CASES.

The incision is made in the skin in an oblique direction. The external oblique fibres are then separated, and afterwards those of the internal oblique and transversalis. This opening is enlarged with scissors until the edge of the rectus is exposed. The layers of the sheaths of the rectus are then cut up and down, as indicated.

to remove the appendix at a later date. The obliteration and destruction of the appendix which goes on concurrently with the formation of an abscess is, in his opinion, a strong argument for deferring operation in those cases where the inflammatory process is manifestly shut off from the peritoneal cavity, as evidenced by the wall of adhesion surrounding it on all sides as well as posteriorly, a wall "as sharply defined as the margin of the liver." He draws attention to the comparative advantages of the intermediate operation, pointing out that, if the operation is done before the suppuration of the entire exudate ("*Falls der Kern des perityphlitischen Exudats noch nicht eitrig eingeschmolzen ist*"), the operator is under the necessity of finding the appendix in the midst of adherent intestines and scattered deposits of pus, fibrin, and exudate, as there is under such conditions no assurance that the peccant organ will be so involved in the cicatrix during the healing process as to become harmless for the future.

NEUMANN (*Langenb. Archiv f. klin. Chir.*, 1901, Bd. 62, Hft. 3) advocates the plan of a secondary operation for removal of the appendix, after the draining of the abscess, claiming for it the following advantages:

1. The duration of the original operation, which occurs at a time when the patient is more or less exhausted, and when every effort should be used to sustain vitality, is much shortened.
2. It prevents an already existing peritonitis from spreading, and avoids exciting a fresh peritonitis by exposing closed peritoneal surfaces.
3. The appendix can be removed at the secondary operation close to the cæcum, while the patient is in good condition and the absorbing power of the peritoneum possesses its normal activity.

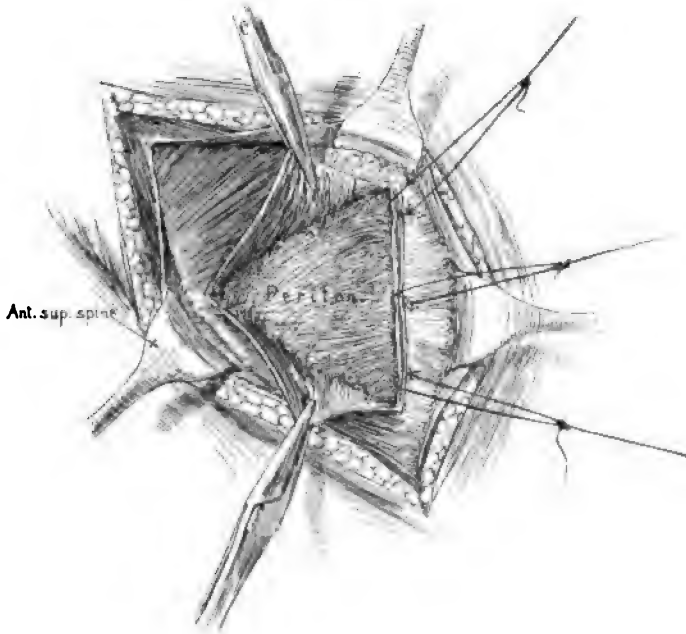


FIG. 156.—THE TRIANGULAR FLAPS THUS FORMED ARE DRAWN UP AND DOWN, GIVING A WIDE AREA OF EXPOSURE TO THE PERITONEUM.

If the wound is to remain open for packing, the several structures are identified by loops of silk.

4. Adhesions are easily freed and the formation of fresh ones avoided.
5. The risk of ventral hernia is greatly lessened.

When the appendix exceeds the normal length and the diseased area is situated in the tip, the location of the abscess may be more or less distant from the usual site of an appendix. The same unusual location is found when the position of the appendix is abnormal from congenital displacement of the caput coli, especially when the latter is high up behind the liver; or when a previous attack of inflammation, resulting in contraction, causes upward displacement of the cæcum.

Treatment of Abscess.—EVACUATION.—The best place to open an abscess is at the site indicated by nature through swelling and tenderness.

A free incision should be made over the location of the pus and rather to the outside, near Poupart's ligament, or the spine or crest of the ileum, and in the direction of the external oblique muscle. (Edema of tissues under the skin or beneath the muscles is an indication of pus near at hand, a little deeper in. It is a good plan to pull the muscles widely apart without cutting them, and then to open the abscess by a blunt dissection; if it is large enough to need a freer avenue of drainage, an incision can be made, both up and down, through the entire thickness of the abdominal walls. Fig. 154 shows WEIR's method of securing a large opening through which an abscess or other complications may be dealt with without embarrassment (*Trans. Congrès internat. de méd.*, Paris, 1900, p. 801). DOUGHTY's method (*personal communication*) of securing a large avenue of approach and a better opening for free drainage is seen in Figs. 155, 156 and 157.

It is sometimes very difficult to recognize the peritoneum if it is adherent, and the surgeon should then use a fine needle or the point of a knife

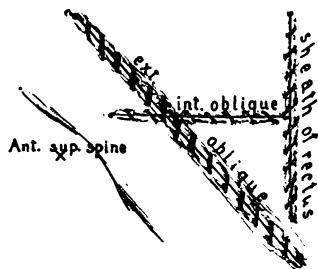


FIG. 157.—DOUGHTY'S METHOD. SHOWS THE COMPLETE CLOSURE OF THE WOUND AND THE RELATIONS OF THE LINES OF SUTURING.

to enter the abscess, introducing a pair of artery forceps with closed blades as soon as the pus appears, and spreading the blades apart after they are inserted; the forceps is then withdrawn and the fingers inserted, in order to keep the hole widely open, and give the pus free exit. If there is any suspicion of the peritoneum, it is best to work carefully backward on the outer side toward the flank in order to open the abscess without disturbing the peritoneum (see Fig. 158). If the unopened peritoneum is found freely movable over the mass, the surgeon has a choice between several plans of procedure. First, the peritoneum may be gently pushed toward the median line, until the mass is reached extra-peritoneally, as just described. Second, the mass is reached extra-peritoneally in a similar manner, after it has first been thoroughly explored through an incision opening into the peritoneal cavity; this opening ought to be closed before breaking into the abscess from the lateral extra-peritoneal route; such an opening clears up the diagnosis as to the extent of the trouble and points out the safe way for the evacuation. Third, the abscess may be emptied trans-peritoneally (see Fig. 159). This last method gives visual command of the field, and better control of all possible conditions

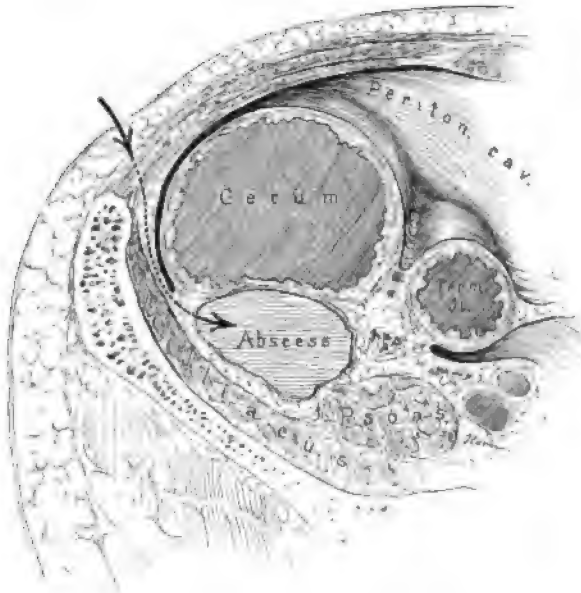


FIG. 158.—DIAGRAM SHOWING THE METHOD OF APPROACHING THE ABSCESS BY THE EXTRA-PERITONEAL ROUTE.

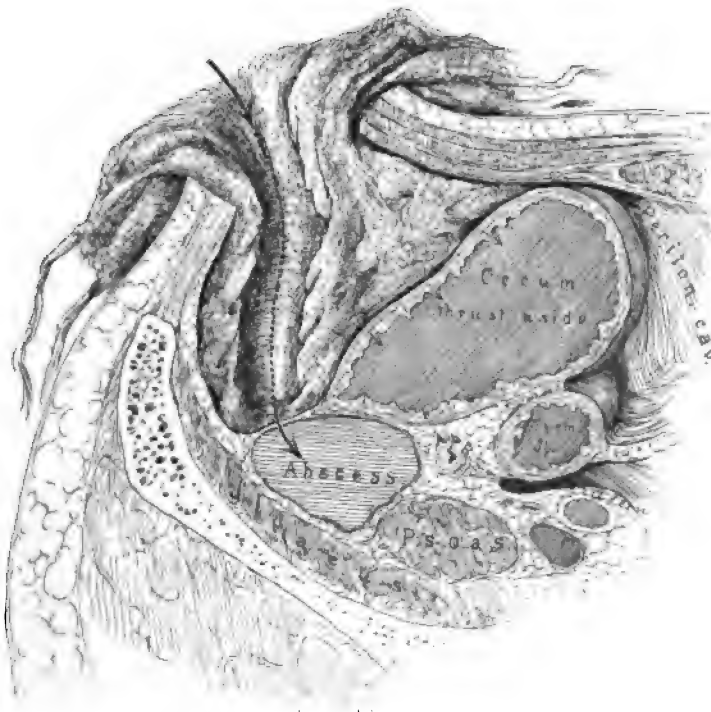


FIG. 159.—SHOWS THE TRANSPERITONEAL METHOD, PACKING OFF THE UNCONTAMINATED PERITONEUM ON ALL SIDES IN ORDER TO APPROACH, EVACUATE, CLEAN OUT, AND DRAIN THE ABSCESS BY THIS ROUTE.

and complications that may arise, and for many cases with abscesses awkwardly disposed toward the interior of the abdomen it is the plan to be preferred. It is contraindicated for very weak patients, whose vitality is better conserved by a simple extra-peritoneal evacuation of the pus. For such a trans-peritoneal treatment a long vertical incision is made, either near the rectus or through its fibrous sheath, so as to deliberately expose the mass on the median aspect. The swelling is then carefully outlined by sight and touch, and then an efficient protective barrier is formed about the mass by means of pads of folded gauze, which hold back every loop of the healthy bowel and protect the abdominal cavity above, toward the middle line and in the true pelvis. Before opening the abscess a few large strips of dry iodoform gauze may be loosely laid about the point of evacuation. The cæcum is carefully raised, and as the pus appears it is taken up with small sponges. The iodoform strips may be removed and replaced as rapidly as they are soiled. When all the pus and fibrin that the gauze sponges will remove have been taken up, the appendix is dealt with as best suits the case. After its exposure, a large abscess is often best treated by aspiration, to take off the tension and the excess of pus; it may then be opened and cleaned, the appendix being removed, if it is accessible. Other foci of pus should then be carefully evacuated in the same way.

If a second mass is found in the lumbar region or in the pelvis, it may be best to make a separate incision or a counter-opening at the nearest point on the abdominal wall. In women a vaginal puncture and free drainage are often most useful, and in men a similar puncture through the rectum is occasionally of great service.

After evacuating all pus and thoroughly opening and cleansing the cavities with dry gauze, the infected areas should be loosely packed with washed-out iodoform gauze (SANGER). The protective gauze pad may then be withdrawn, and the wound closed with a wide opening for the exit of the iodoform gauze. After emptying the right iliac abscess, the surgeon must carefully palpate the adjacent accessible regions, within the limits of safety, in order to discover any communicating or secondary abscesses, which may be found at any of the points shown in Fig. 160. He should also bear these regions in mind throughout the convalescence.

CLEANSING THE ABSCESS CAVITY.—Too much stress cannot be laid upon the necessity for care and dexterity at this stage. WALSHAM (*Treatise on Appendicitis*, 1901, p. 22) cites a good example of the harm which may result from any but the gentlest manipulation. A boy, aged seventeen, was admitted to hospital with acute appendicitis, on the seventh day of the disease. An incision, about one and a half inches long, was made just above the outer part of Poupart's ligament, and a localized abscess containing two ounces of pus was opened. A finger was then introduced to explore the abscess, and the latter was washed out. The temperature and pulse both rose gradually after the operation, the patient became very restless and died on the second day. The postmortem, which showed

that the appendix was ulcerated and contained a concretion, also showed that a hole had been accidentally made through the adhesions into that part of the peritoneal cavity which had been previously healthy, and that

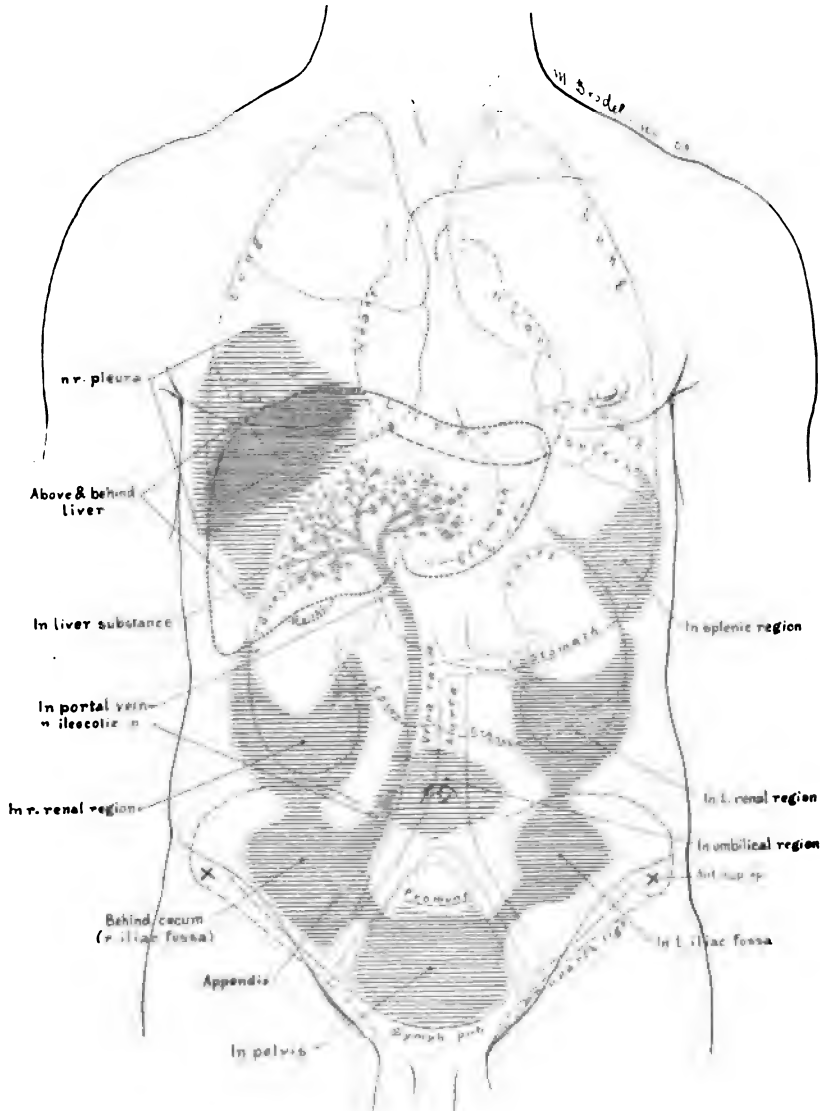


FIG. 160.—SHOWING THE VARIOUS SITES AT WHICH ABSCESES ARE MORE COMMONLY FOUND.

The appendix is seen below on the right in the centre of a chain of abscesses which extend upward on the right into renal region, supra-hepatic and right pleural, or into the liver by portal vein. The extension up the left side is usually effected by traversing the pelvis, the left iliac fossa, and the left renal fossa. Occasionally the abscess is found located among the intestines in the neighborhood of the umbilicus, and rarely in the splenic region.

through this hole, pus and lotion had been injected into the general peritoneum, thus setting up septic peritonitis! After the abscess is evacuated and wiped dry, it is often advantageous, especially if the cavity is a small

one, to sterilize it as thoroughly as possible. This may be done by means of a strong antiseptic solution applied for a brief space of time and wiped off. For a small abscess pure carbolic acid is most efficient, applied on a little pledget of cotton, care being taken that no excess of acid is allowed to run over adjacent tissues; if this is followed by an application of pure alcohol, no harm ought to result from its escharotic tendency; great caution, however, must be used in the proximity of the iliac vessels or in applying it on the bowel. This form of treatment is best suited to small indurated cavities containing a little pus, which are attached to the cæcum, lie behind it, or are lodged in the true pelvis. Large abscesses I swab out with a solution of mercuric chloride (1 : 1000) or a solution of formalin followed by plain water. Fetid abscesses may be cleansed with peroxide of hydrogen.

DRAINAGE.—An abscess cavity should never be disinfected and closed without drainage. When there has been much pus, a large opening ought to be left for free drainage; but before the drain is inserted, the relations of the abscess must be studied, and pressure made upon it in various directions, in order to ascertain that there is not some other cavity communicating with the primary one. If there is, it should be explored to its bottom, and if it extends into any other dependent position, such as the right renal region or the floor of the pelvis, a counter-opening should be made there also. The pelvis in particular should be carefully explored to discover a possible *hour-glass abscess*, that is to say, an abscess of the iliac fossa communicating with the pelvis, often by a narrow and almost imperceptible orifice or channel, which is one of the most dangerous of all forms of secondary abscesses. Douglas' *cul-de-sac* should always be explored when there are no adhesions to contraindicate it by the introduction of gauze on a probe.

The essential points to be remembered in drainage are these:

The drain is only a drain to a limited extent and for a short time; it acts chiefly as a protective pack.

It is essential that the whole septic area should be drained.

The drain must be loose in order that it may absorb rapidly. It must never be firmly packed.

The drain must have exit through a large orifice.

Whenever possible, the drain must be to an orifice in a dependent position.

The drain must be watched and as soon as it ceases to discharge it must be loosened or wholly withdrawn.

In a small abscess it is sometimes best to leave the drain in for a week. Fatal infection has occurred from removing it too soon and thus breaking up protective adhesions.

One of the most dangerous forms of abscess is that in which there is a small accumulation of pus, it may be not more than a few drops, walled off about the tip of the appendix. Such cases are oftenest found at the tip of an appendix dipping into the pelvis; Fig. 161 represents one of these abscesses high up in the neighborhood of the hepatic flexure.

The danger lies in the fact that the operator is tempted either to cleanse the cavity and close it entirely, or to attempt to get along with insufficient drainage by a long and circuitous route. It is imperative that operators should confer upon these minute abscesses all the dignity of the larger form, treating them with the most extreme care to avoid any contamination of the peritoneum, sterilizing the cavity with painstaking care, introducing an abundant gauze drain, which should be left in for five or six days, and, lastly, draining onto the surface by the most direct avenue, even if it is necessary to make an additional incision or to enlarge the incision already made. Fig. 162 shows the cause of the minute abscess, namely, a pin-point perforation of the tip of the appendix.

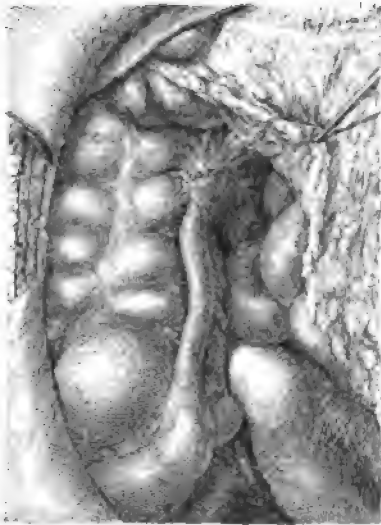


FIG. 161.—DOWNES'S CASE SHOWING THE UNUSUAL LOCATION OF THE ABSCESS HIGH UP TO THE INNER SIDE OF THE ASCENDING COLON, COVERED BY THE OMENTUM. RECOVERY.



FIG. 162.—DOWNES'S CASE OF PIN-POINT PERFORATION, a, OF THE TIP OF THE APPENDIX; b, RAGGED AREA ADHESIONS WALLING OFF ABSCESS. (Natural size.)

The best material for drainage is washed-out iodoform gauze, used in strips two or three inches wide and about twenty inches long, and in two or three thicknesses. Before introducing the drain, all sound bowel should be lifted up *en masse* to one side, and held off from the abdominal parietes; then, with the abscess cavity freely exposed, it is loosely filled with strips of gauze. If the abscess is in the pelvis, it should be loosely stuffed on all sides, in such a manner that the sound bowel rests upon the gauze. Great care must be exercised in introducing the gauze, for many cases have been lost from a kink in the bowel after operation resulting in an obstruction. According to HALSTED, a small drain may be more effective in causing the kink than a large one. The packing should always keep the intestines away from the drainage area as one solid organ, and the gauze must not be left among the coils. For this purpose "the cigarette drains" used by MORRIS and by WARREN (see p. 360) are very satisfactory.

The size of the drain must depend upon the nature of the infection. During operation a smear should be taken, and if nothing is found except the colon bacillus there is no reason for special caution; if, however, the streptococcus or staphylococcus is present, there must be a wide drain with everything left open. The drain may remain untouched from five to seven days or longer provided the patient

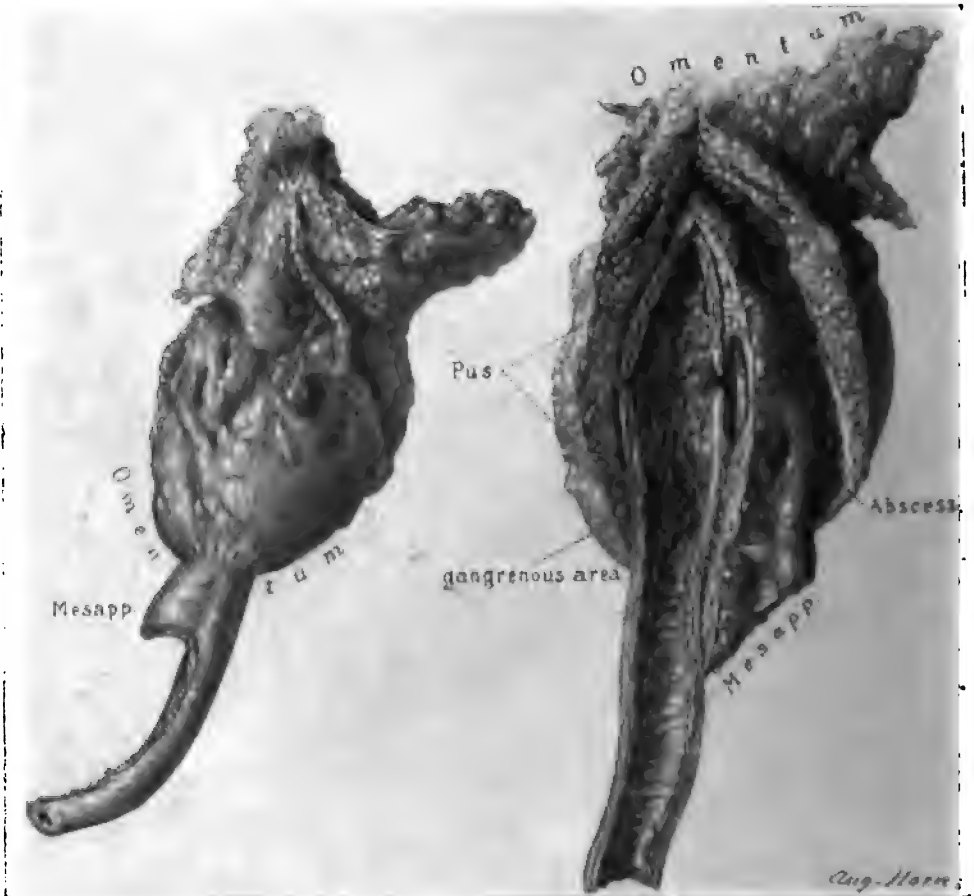


FIG. 163.—FOLLIS'S CASE. GANGRENE, ABSCESS, AND PERFORATION OF THE APPENDIX AS SEEN IN THE RIGHT-HAND FIGURE, COMPLETELY ENVELOPED AND PROTECTED FROM PERITONEAL CAVITY BY OMENTUM AS SHOWN IN LEFT-HAND FIGURE.

The omentum formed a tight constricting neck around the appendix beyond the disease. R., boy thirteen years old, Nov. 23, 1903. Recovery. (Natural size.)

is improving. As long as there is a free flow from the wound, it need not be disturbed. It should not be removed on account of an elevation of temperature during the first day or two when the patient is otherwise doing well.

In removing the gauze it is well to use traction forceps in order that it may be drawn out steadily and slowly. If there is much pain in doing this, nitrous oxide gas or a few whiffs of chloroform may be administered.

The second tampon should be much smaller than the first, in order to favor the collapse of the abscess cavity. The external skin opening of the drain must always be kept freely open, and the gauze should never be allowed to plug the orifice and bottle up the secretions. If necessary, a hot saline poultice may be used to soften the gauze and facilitate its removal.

TREATMENT OF ABSCESS IN SPECIAL CASES.—In some unusual cases I have adopted the plan of opening the abdomen in the median right semilunar line, and then, when the abscess is located and found accessible by



FIG. 164.—SHOWS THE METHOD OF EXPOSING AN ABSCESS BY AN INCISION IN THE RIGHT SEMILUNAR OR MEDIAN LINE AND THEN OPENING AND EVACUATING IT EXTRA-PERITONEALLY BY A SECOND SMALLER INCISION IN THE RIGHT LOIN.

an extra-peritoneal route, I have made a second incision in the skin, close to the crural arch (Fig. 164) or to the spine of the ilium, and worked up beneath the peritoneum until the abscess was reached and evacuated, one hand acting through the second incision, and being guided by the other hand and the eye acting through the first (Fig. 165). After evacuation of the abscess, every adjacent part must be examined by bimanual palpation with the hand inside to discover any remaining foci of pus. The clean abdominal wound must then be closed by an assistant who has not been contaminated, or, if it is done by the operator himself, he must first change his glove; the lateral incision is left open for drainage.

The most favorable of all abscesses are those encapsulated in the omentum (see Fig. 163), and in some such cases it is possible to excise the whole abscess cavity enclosed in the omentum, and close the wound without drainage. VAN HOOK, on opening the peritoneum in a case protected by the omentum, found a layer of it lying between the tumor and the abdom-

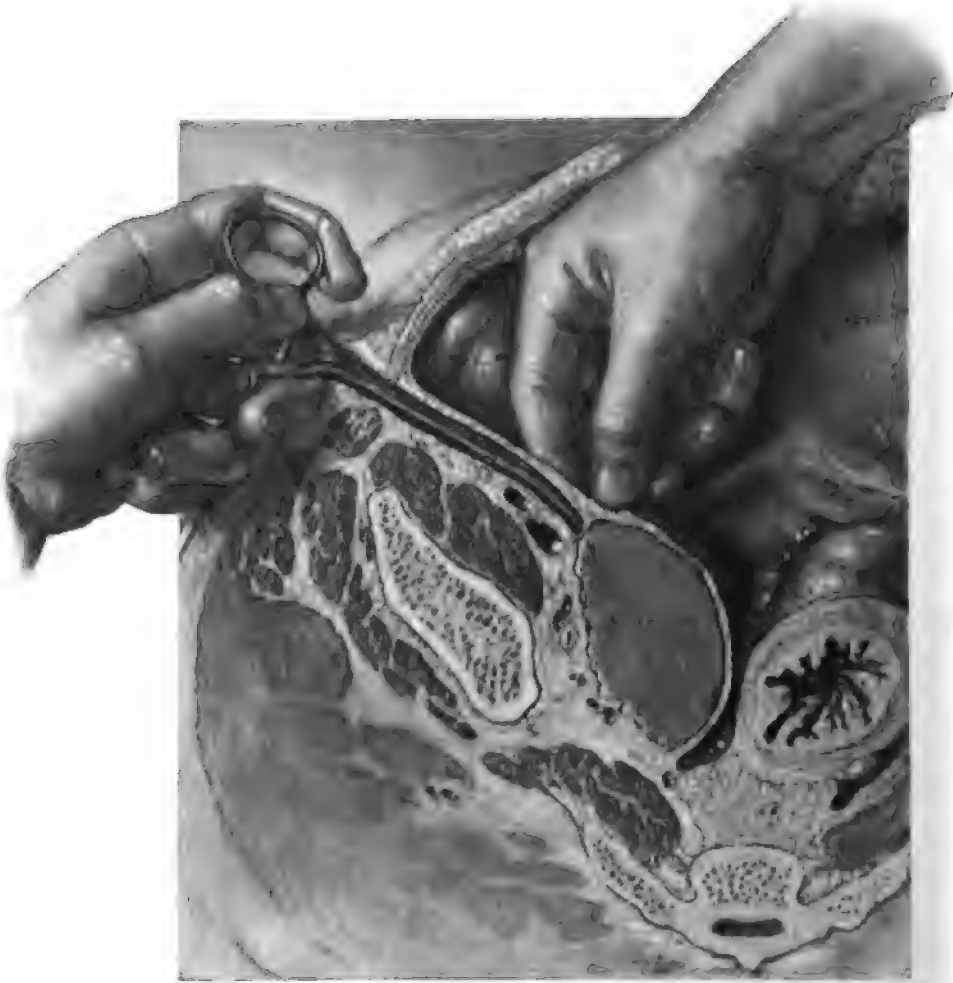


FIG. 165.—SHOWS THE HAND WITHIN THE ABDOMEN GUIDING AND CONTROLLING THE FORCEPS IN THE ACT OF OPENING AND EVACUATING THE ABSCESS THROUGH THE LATERAL INCISION.

inal wall. He stitched the omentum to the parietal peritoneum, and the next day he opened the pus cavity. The patient made a good recovery.

Abscess Connected with a Gangrenous Appendix.—TERRIER, who has insisted with great emphasis (*Rev. de chir.*, Jan., 1900) upon the importance of certain anaërobic bacilli as a causative factor in some of the worst forms of appendicitis, especially the

gangrenous, points out that the suppurative processes due to these bacilli can be recognized by their extreme fetidity, and that they rapidly produce the gravest lesions. The temperature in a case of this kind is apt to be low, while the pulse runs up, it may be as high as 140, and the case presents all the appearance of a rapid and grave intoxication. Terrier anticipates that the study of this new class of organisms in their relation to appendicitis will disclose a near connection between clinical forms of appendicitis and the bacterial agents at work in their causation. He also believes that the local phenomena in such cases as he describes will eventually be shown to depend upon the specific infection rather than upon special anatomic considerations ("*Recherches sur quelques microbes strictement anerobic et leur rôle dans pathologie*," *Arch. de méd. expér.*, July, 1898, p. 517). The understanding of the anaërobic nature of some of the worst infections leads to one deduction of great practical importance, namely, the necessity in such cases for opening the wound largely and using peroxide of hydrogen in dressing all infected parts. In one of the cases cited by Terrier, where there was a fetid suppuration and sloughing of the whole appendix due to anaërobic infection, a gangrenous phlegmon was found in the abdominal wall, and the patient's life was only saved by extensive incisions in the tissues, begun at the earliest possible moment and repeated several times in the effort to combat the rapidly invading gaseous gangrène. The necrosed cartilages of several ribs had to be resected in treating the last focus of suppuration. Peroxide of hydrogen was repeatedly and extensively used in association with the aggressive surgical treatment.

Another dangerous but fortunately rare form of abscess is that occurring between the layers of the mesentery of the small intestine. An interesting case of the kind is reported by J. C. BLOODGOOD (*Jour. Med. Sci.*, 1903) in which the appropriate treatment is incidentally demonstrated.

Pelvic Appendical Abscess.—ARCHIBALD (*Montreal Med. Jour.*, 1890, p. 81) in 22 cases of abscess originating in the appendix found 7 situated in the pelvis. ROTTER (*Dtsch. med. Woch.*, 1890, No. 39) out of 132 abscesses starting in the appendix found 40 which were pelvic, and of these 40 cases there were 27 in which the appendix itself was located in the pelvis. In 21 cases out of the 40 the pus was situated in the pelvis alone, while in the remaining 19 the pelvic abscess was associated with an extension into other regions. Out of the 21 cases in which the abscess was confined to the pelvis there were 7 in which it was concealed in the true pelvis and not perceptible to abdominal examination, but in 14 cases it could be felt through the abdominal walls. In the 19 cases of pelvic abscess with extension, the right iliac fossa was the seat of the second abscess 14 times and in every instance the iliac abscess was isolated from the pelvis. In 3 cases the extension of suppuration was into the left iliac fossa. Out of 24 pelvic abscesses collected by BÉRARD and PATEL, the suppurative process was confined to the pelvis in 11 cases: in 7 there was an avenue of communication between the iliac and pelvic abscesses; in 4 the pelvic suppuration was secondary to iliac abscess; and in 2 there was a pelvic abscess with

bilateral iliac diverticula. Bérard and Patel divide these pelvic abscesses into two classes: the *peri-appendical*, in which there is a direct connection with the abscess surrounding the appendix; and the *para-appendical*, in which the appendix is situated above the pelvic brim and has no apparent direct communication with the abscess.

Sometimes there are two abscesses, one surrounding the appendix on the iliac fossa and another filling the pelvis; these may be entirely distinct from each other, or they may communicate more or less freely over the brim of the pelvis under the adherent coils of intestines. A. C. BERNAYS, of St. Louis, has employed a method which throws light on the mode of origin of pelvic abscesses. In an incipient peritoneal infection without pus, he always introduces a long glass pipette as far as the floor of the pelvis and catches the secretion from there, in which he almost invariably finds abundant bacterial flora, which develop on suitable media.

BROCA (*Bull. méd.*, June 29, 1901, p. 589) distinguishes two sorts of abscesses under the title superior and inferior pelvic. Superior pelvic abscesses start near the superior strait, in which situation they may be quite out of reach in an examination through the abdomen or by rectum. Later on, as they develop, they become iliac, or again pelvic, or at once both iliac and pelvic. Inferior pelvic abscesses cannot be detected by an examination from above, but they are perceptible to the rectal touch, as they generally lie in close association with the anterior wall of the rectum. In rare instances the sigmoid flexure lies between such a collection of pus and the rectal wall. These pelvic abscesses are walled off from the general peritoneal cavity by a layer of adhesions uniting the small intestines one to another.

Sometimes after the disappearance of an acute appendicitis, rectal palpation reveals a line of infiltration against the pelvic wall, and possibly a very tender spot in the wall of the bowel. The patient may also complain of severe pain on straining in the evacuation of the bowels. These signs point to an appendix hanging over the brim into the pelvis and attached to the rectum.

SYMPTOMS.—The special symptoms of pelvic abscess are radiation of the pain down the right leg, McBurney's point being generally painless, as the pus is located lower down; but most characteristic of all are the signs of pelvic peritonitis, consisting of vesical and rectal disturbances. The vesical disturbance sometimes amounts to little more than frequent or painful micturition. In other cases there is decided tenesmus, noted soon after beginning of the attack. Retention of the urine has also been observed in some instances. Rectal tenesmus is a frequent sign, beginning generally on the second day and lasting for a short period. In two instances a diagnosis of nephritic colic has been made on account of the pain radiating down the inguinal region and into the testicle ("*De l'appendicite pelvienne*," CHEVALIER, Paris, 1900). In another instance anuria coexisting with tenesmus and hypogastric swelling gave rise to a diagnosis of retention of urine. An important means of recogniz-

ing the involvement of the appendix is through the radiation of the pain toward the umbilicus when pressure is made over the position of the diseased appendix.

DIAGNOSIS.—The diagnosis is established chiefly by rectal and vaginal palpation, the physician's right forefinger or the forefinger and middle finger of the right hand being employed to investigate the right side of the pelvic cavity.

TREATMENT.—The recognition of pelvic abscess is essential to its proper treatment and is, therefore, of great importance. One of the most important avenues for opening, evacuating, and draining an abscess in the region of the appendix is through the *rectum*. The rectal passage is a particularly satisfactory method in men, in young women, and in children, and is especially suitable in all cases of large pelvic abscess filling the pelvis, as well as in all those in which an abscess actually points in the bowel. In advanced cases rectal evacuation has the advantage of causing little shock to the patient, while at the same time it offers the greatest of all desiderata, namely, an opening at the bottom of the area to be drained; whenever it is possible make an opening posterior to the cervix uteri or into the rectum, and thus secure drainage in a dependent position.

In a married woman, especially in a multipara, the retro-uterine peritoneal pouch affords a most convenient avenue for drainage by the *vagina*, which at the same time is free from any objection on the score of contamination from fecal discharges. When the abscess can be felt through the posterior *cul-de-sac*, this should in all instances be opened. The operation is done by retracting the posterior vaginal wall so as to expose the vault; the cervix is then caught and drawn forward, while the vaginal vault just behind the cervix is laid open from side to side with scissors or knife. As soon as the bulging peritoneum is reached, it is opened widely and then stretched to a maximum from side to side by hooking in the right and left index-fingers. This gives free exit to all discharges, and the cavity may be carefully washed out, a rubber tube being inserted with a loose pack of iodoform gauze. In a child either the rectum or the superior strait must be utilized (see Fig. 166).

When the abscess is located entirely in the pelvis, the indication is to find the point of least resistance through the inferior strait and to make an opening there. To evacuate a collection of pus by separating the agglutinated intestine through the superior strait is exceedingly dangerous. QUÉNU's method, in two steps, is also not to be recommended, if the collection can be reached from below. The first step in his procedure is to open the peritoneal cavity, locate the abscess, and introduce the tampon down to it, so as to establish an avenue for the escape of the pus. The next step is to open the abscess at a later date.

It sometimes happens that an operator is surprised upon opening the abdomen to discover, as in CULLEN's case (Fig. 167), a large accumulation of pus in the pelvis, the exact position and size of which are only known after sufficient adhesions have been separated to release the pus and make

it imperative to proceed. In such cases, although the point of election for the opening would have been by the vagina in a woman, or by the rectum in a man, the operator, having advanced so far as to open the abscess from above, is obliged to proceed with the evacuation in this direction. The closest attention must be given to protecting the surrounding peritoneum, while the entire pus cavity is emptied and dried, a liberal drainage orifice filled with loose gauze being provided, which also fills the infected pelvis.

The para-sacral method was clearly defined by JABOULAY in 1892 (*Rev. de chir.*, 1892), but it is the very last to be recommended, unless, as in the case of BÉRARD and PATEL, the collection of pus finds its way back to the sacro-iliac notch and tends to open spontaneously at that point.

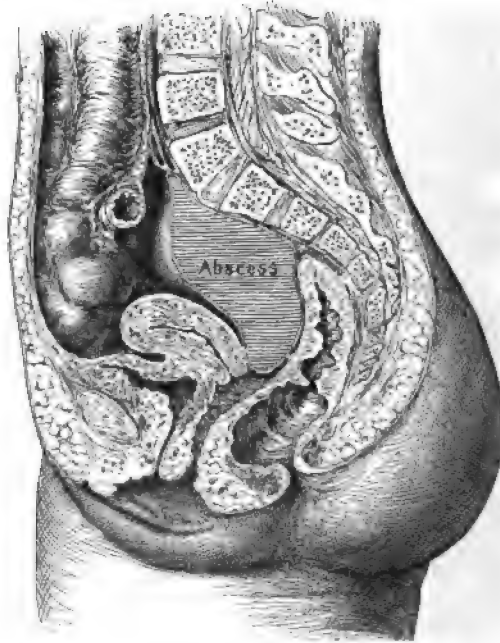


FIG. 166.—Gallant's case. Large retro-peritoneal abscess in a girl ten years old extending from the region of the appendix behind the pelvic peritoneum and pointing back of the cervix uteri, where it bulges into the vagina. Vaginal drainage impossible on account of age of patient. Drainage above. Recovery.

The perineal method, devised by MAUCLAIRE in 1895 (*Soc. Anat.*, 1897, p. 868), has been utilized by DELANGLADE, who has written an article upon it, entitled "*De l'incision prérectale des abcès pelvienne appendiculaire*" (*Soc. de chir.*, Paris, 1900, pp. 600 et 857). E. M. SUTTON, LAGOUTTE, and especially ROTTER have also used the perineal method, the latter eleven times.

SUTTON (*Jour. Amer. Med. Assoc.*, 1898, vol. 30, p. 1438) reports the case of a locomotive fireman, thirty-five years old, in whom a pelvic abscess was watched into the second week, when, on account of symptoms of obstruction, such as vomiting and distention, it was evacuated through the rectum by puncturing the anterior wall high up, with a small trocar, upon which 22 ounces of pus escaped. After some amelioration, severe

septic symptoms followed, and the abscess was found to have refilled. It was then opened and drained through the peritoneum by making a horse-shoe incision in front of the anus, and carrying the dissection carefully upward between the urethra and the rectum; the external sphincter fibres were divided, where they interlace with the bulbo-cavernosus; the deep fascia also was divided, the levator ani separated, and the prostate when reached was pushed forward as the dissection was carried up to the peritoneal *cul-de-sac*. On reaching this point, the abscess cavity was opened,

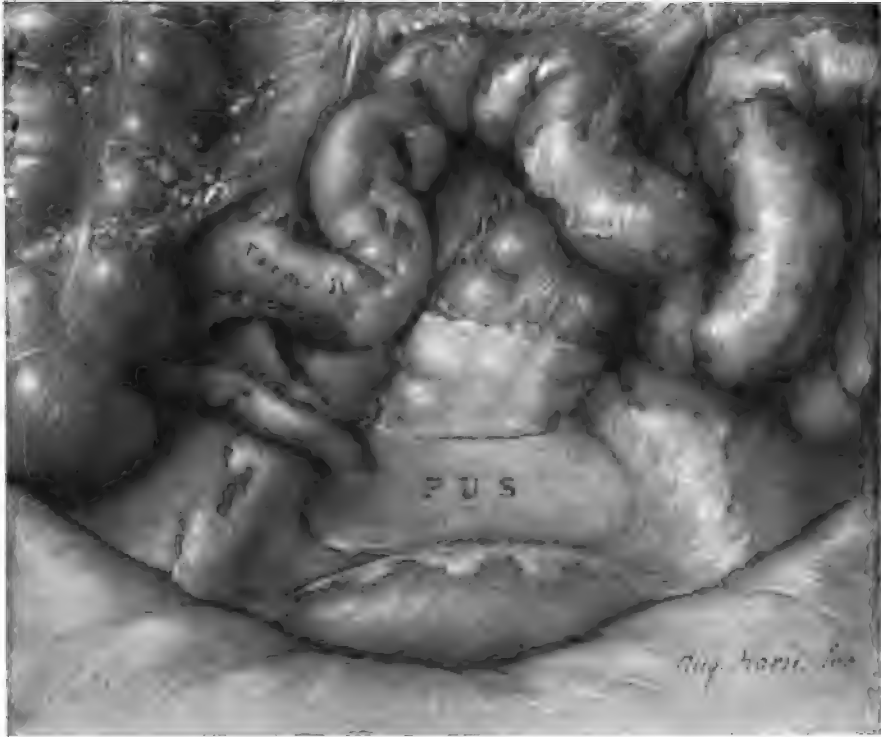


FIG. 167.—CULLEN'S CASE. THE TIP OF THE APPENDIX IS LOST IN A POOL OF PUS FILLING THE PELVIS AND WALLED IN BY ADHERENT SMALL INTESTINE EVERYWHERE COVERED BY LYMPH.

The intestine has been lifted up and the adhesion separated so as to show the abscess. Church Home. Removal of appendix, drainage. W. P., male, æt. twenty-seven. June 26, 1902.

and nearly a quart of foul pus mixed with liquid feces escaped, after which a drainage-tube was inserted. The temperature and pulse dropped to normal, the bowels moved six hours after the operation, and the intense suffering was immediately relieved. The drainage-tube was removed on the twelfth day, and the patient was able to be out of the house the third week.

The method of opening and draining the abscess by the rectum is as follows: The rectum is emptied and washed out, and when the patient is well under an anæsthetic the anterior wall is exposed by means of a Sims speculum or by long narrow retractors. The incision is then made near the median line and in front, where the vessels are least voluminous, or

at a point which has been determined by the finger as the most prominent or the most yielding portion of the inflammatory mass. The operator should have previously determined, by careful bimanual examination with one finger in the rectum, the exact location and the size of the abscess. The dilatation of the anus is effected by the traction instrument used to expose the field of operation. In case of doubt as to the presence of pus an aspirating syringe may be used, passing the needle obliquely through the wall of the bowel.

BÉRARD and PATEL advise a transverse incision, crossing the median line, made with curved scissors under the control of the left index finger; the coats of the bowel are then cut through successively and in an oblique direction proceeding upward. As soon as the abscess is opened, the orifice is enlarged by introducing the scissors and then separating the blades; after the abscess has been explored by means of the finger it can be completely evacuated by pressure made softly from above. The cavity should then be gently washed out until the fluid returns clear.

Drainage ought never to be omitted, and it is best carried out by means of rubber tubes a centimetre in diameter. A mushroom tube of this size is readily retained, while the outer end of it, lying on the exterior, conducts the discharges on to a gauze pad. Through such a tube the cavity can be washed out from time to time under gentle pressure.

R. PETERSON (*Amer. Jour. Gyn. and Obst.*, 1900, vol. 16, p. 240) opened an abscess containing over a gallon of foul pus, which pointed just within the anus. On the sixth day afterward the patient walked home, a distance of about a mile and a half, and made a rapid recovery.

In order to avoid a reflux of stercoral materials into the abscess JABOULAY recommends the following method, which he has occasionally practised: The coats of each lateral wall of the rectum are brought together behind the drain and fixed temporarily at the anus in such a manner as to form a double canal, one opening being in front for drainage and one behind for the escape of fecal matter and gas.

CHAPTER XIX.

PERITONITIS.

WHEN infection spreads beyond the bounds of the original focus of the disease in the appendix (see Fig. 168), it may be limited, as we have just seen, to the neighborhood of the diseased organ by a wall of adhesions agglutinating the adjacent intestines and the general peritoneum. If for any reason however, such as the suddenness of the outbreak, the peritoneum is unprotected or unable to defend itself on account of the virulence of the organisms, and the infection is poured over a larger area of the peritoneal cavity, the resulting peritonitis either becomes diffuse or even universal as it enlarges its boundaries. On the contrary, it may become encapsulated here and there between the viscera, forming so many separate foci of suppuration by which the disease advances, establishing new foci from point to point.

A peritonitis arising in this way, whether focal or diffuse, possesses all the characteristics of the original disease in the right iliac fossa, resembling the lesser areas of infection in every point except in the extent of surface involved. The profound shock and the depressing effect upon the patient which characterize this form of the affection are due simply to the large area involved, associated with the absorption of toxins and pathogenic bacteria. In the more extensive forms of peritonitis we observe such variations in the character of the inflammatory changes as are indicated by the terms serous, fibrinous, purulent, putrid, or hemorrhagic. One or more of these forms may predominate in any given case, or even in different areas of disease in the same case.

Focal.—One of the most distinctly characterized forms of peritonitis is the disseminated focal, described by MIKULICZ under the term progressive fibrino-purulent (*Langenb. Arch.*, 1899, vol. 39), in which the disease, running an acute or a subacute course, advances by means of the peritoneum to an adjacent area, where it forms a fresh fibrino-purulent deposit, at first shut off by adhesions from the remaining intact peritoneum. It next infects a fresh area through the escape of pus between the adherent coils of intestine and starts up another focus of deposit, walled off in its turn, only to again advance to some other point in the neighborhood and thus continue its progress.

Secondary abscesses of this description are met with behind the caecum, in the pelvis, in the right renal region above the liver, in the right pleura, in the left iliac fossa, in the left renal region, and among the coils of the

intestines. (See Fig. 160.) JAFFÉ speaks of cases in which he found secondary abscesses above and to the inside of the spleen. A surgeon must bear in mind all these seats of predilection in every case in which the opening of an abscess in the neighborhood of



FIG. 168.—SHOWING PERFORATION NEAR THE ROOT OF THE APPENDIX IN A PATIENT DYING OF PERITONITIS. J. H. H. M. S., æt. sixty. Aug., Sept., 1903. Surg. Path. No. 2181. The kink is probably responsible for the location of the perforation.

the appendix is not followed by immediate improvement. Only by the closest attention to all parts of the abdominal cavity and to the pleura can he exclude the presence of one or more of these foci of secondary infection or suspect and watch some particular area, prepared to open and drain the abscess as soon as it is formed. The effect of a concealed,

unopened abscess upon the general condition of the patient is so marked as to be evident even to the untutored eyes of the family anxiously watching for signs of improvement. The course of the affection is more protracted than that of a diffuse peritonitis, and there is not the same evidence of profound intoxication. The fever is usually high, the pulse is quickened, there may be chills, and there is certainly restlessness, abdominal discomfort, tympany, and often pain in the affected region. At this juncture a careful palpation of the abdomen, made by little quick movements of deep pressure with the finger-tips as they play the gamut of the muscular fibres, will often localize the affected area in the right or left lumbar region. The affected areas are markedly sensitive, and as the fluid accumulates, resistance increases, while the area of dulness is enlarged, as revealed by light percussion. The pelvis must be investigated by rectal examination in order to discover any unusual tenderness, boggy condition, bulging or infiltration of its walls. The liver should be investigated by auscultation and percussion, in order to detect any friction sounds indicating a perihepatitis or any enlargement of the area of dulness, such as would be produced by an abscess. Any icteroid tinge of the skin or conjunctiva must receive the closest attention. A bulging of the ribs may indicate an empyema.

Not only one, but two or even more secondary abscesses may form, necessitating several operations. An instance of this kind occurred in the practice of W. S. HALSTED, myself, and J. M. T. FINNEY, each of us operating successively on the same patient. ("The Vermiform Appendix and its Diseases.")

Another series of sequences is shown in a case operated upon by Professor PONCET, the patient entering his clinic in March, 1892, with "alarming symptoms of appendicitis." This patient was operated upon successively at several days' interval for (1) a peri-appendical abscess in the right iliac fossa, (2) an abscess above the liver, and, finally, (3) a purulent pleurisy (E. SALLET, "*Des abscesses peri-hepatique*," *Thèse de Lyon*, 1894).

SUBPHRENIC ABSCESS.—One of the most important of these secondary abscesses is that in which the purulent deposit is situated above the liver and below the diaphragm, in other words, a *subphrenic abscess*. This form of abscess has been well described by ELSBERG, who justly remarks that its importance as a complication is not sufficiently recognized. He has collected 73 cases in all, 2 of which occurred in his own practice. His treatment of the subject is so satisfactory that I cannot do better than quote his words (*Ann. Surg.*, 1901, vol. 34, p. 729):

"Subphrenic abscess processes secondary to disease of the vermiform appendix may occur in one of three ways:

"1. As a localization in the right or left subphrenic region of a general systemic infection,—the infectious agents being carried to the subphrenic region by the blood current. Here the process is secondary to a generalized infection and hence is not considered in this paper.

"2. As a localized abscess formation in the right or left subphrenic region, a part of a general purulent peritonitis with foci of suppuration in

various parts of the abdominal cavity. This variety is infrequent, as the patients generally die before encapsulation of the abscess can occur.

"3. As a local process by direct extension, or through the lymph-channels from disease in or around the vermiform appendix. This is the most frequent variety and the one with which this paper is concerned.

"According to Fränkel, inflammatory processes in the region of the liver may lie entirely within the peritoneal cavity or entirely outside of it. The intra-peritoneal variety is usually the result of the direct extension of the inflammation from below. In the extra-peritoneal variety the process advances by the retro-peritoneal route, behind the ascending colon and kidney. The abscess generally lies behind and above the kidney, and unless it is very large causes little or no downward displacement of the liver."

H. L. BARNES (*Brit. Med. Jour.*, 1908, vol. 1, p. 429) reports 76 consecutive cases of subphrenic abscess which had occurred in the London Hospital. Of these 12 were due to appendicitis, 21 to gastric ulcer, 18 to liver disease, and the remainder to fourteen different pathological conditions. That is to say, appendicitis was responsible for a sixth of the cases at that hospital. This is a smaller proportion than ELSBERG found, for he says:

"In the large majority of patients the subphrenic affection is secondary to a suppurative inflammation in or around the appendix. Of the 73 cases under discussion, there was an abscess in or around the appendix in 50 cases (68 per cent.): in the other 23 no details were given. When the subphrenic inflammatory condition is caused by direct extension from below, its position varies with the location of the diseased appendix. Of the 73 cases the appendix lay behind the cæcum or the ascending colon in 17 patients (23 per cent.), in front of or below the cæcum or the colon in 12 patients (16 per cent.), and details were wanting in 44 patients (60 per cent.). In about 15 per cent. of the patients the abscess contained gas. Perforation of the diaphragm occurred in 25 per cent. of the cases.

"The symptoms of subphrenic inflammation may come on days, weeks, or months after the disease of the appendix or the operative measures instituted therefor. Several modes of onset are characteristic.

"(a) A few days after the acute symptoms of appendicitis have been relieved, and the temperature has fallen to normal, the patients complain of pain in the lower part of the right chest, the temperature begins to rise, the area of liver dulness is somewhat enlarged, there are friction sounds over the hepatic region, and tenderness in one or two intercostal spaces. There may be slight or well-marked jaundice. Within a few days the pain over the liver becomes less while the signs of fluid become evident.

"(b) Before the acute signs of appendicitis have entirely subsided, although the local symptoms are much improved, the daily temperature begins to take on a remittent type, and the patient begins to lose flesh and strength rapidly. These patients look very ill from the beginning. They do not complain of much pain, although they may have tenderness in the lumbar region; the most marked symptom is the loss of flesh and strength. No further physical signs may be discoverable until the bulging of the abscess in the lumbar region is found.

“(c) After having recovered from the attack of appendicitis in a satisfactory manner, some of the patients never regain their former health. Without any change in the temperature, respiration, or pulse, the patient complains of continual slight pain in the right chest. The pain persists for weeks or months, although physical examination and aspiration of the right chest result negatively. These patients never look very ill. After a varying length of time, the presence of fluid under the diaphragm, and perhaps also in the pleural cavity, is discovered by means of physical examination and the exploring needle.

“When the subphrenic abscess contains gas, the diagnosis is generally more easy, because of the obliteration of the liver dulness by full tympanitic resonance and because of the presence of succussion sounds. When it does not contain gas, the question may arise whether one has to deal with an effusion into the right chest. Most of the errors in diagnosis that have been made have been along this line. Three conditions are possible: there may be an effusion into the pleural cavity, or there may be both a subphrenic and a pleural effusion, or there may be a subphrenic effusion alone. The differential diagnosis must rest on the fact that when there is a well-marked effusion under the diaphragm there are usually no thoracic symptoms; the upper level of the dulness is a straight line or it is convex upward; there is little change in the line of the dulness with a change in the position of the patient. While in a pleural effusion the respiratory murmur is much diminished or absent below the level of the fluid, in subphrenic effusions the murmur can generally be heard plainly below the level of the fluid. Depression of the liver is frequent in subphrenic abscesses; it is rare in pleurisy, unless the effusion is a very large one. The heart is never appreciably pushed to the right, nor are the intercostal spaces bulged out in effusions under the diaphragm. If the pus is withdrawn by aspiration through one of the lower intercostal spaces, and clear fluid by aspiration higher up, the diagnosis of an association between the two conditions is almost assured. When perforation of the diaphragm occurs, it is characterized by the sudden appearance of symptoms of invasion of the pleural cavity,—cough, rapid respiration, expectoration, and, frequently, rapid collapse.”

BARNARD found leucocytosis in all his cases and he considers this a valuable sign. He also thinks the presence of an abdominal or lower thoracic swelling, noted in 65 per cent. of his cases, an important diagnostic sign.

“The differential diagnosis between subphrenic abscess and abscess of the liver is often very difficult, and sometimes impossible before operation. Abscess of the liver is, however, much more rare after appendicitis than is subphrenic abscess. Pain in the right shoulder-blade is rare in subphrenic cases and frequent in abscess of the liver. Paralysis of the diaphragm, and hence diminution or absence of respiratory movements of the liver, occurs far more often in subphrenic affections. Chills and profuse sweats are more frequent in abscess of the liver. The final and positive diagnosis must be made with the aspirating needle, the puncture being made in the seventh to the tenth intercostal space in the axillary

line unless there are signs of pointing in front or in the lumbar region. The fluid obtained by aspiration should be always examined for liver abscess. The characteristic pus of liver abscess is of a light chocolate color with little or no odor. Foul odor of the pus will generally mean subphrenic abscess and not liver abscess, although the possibility of an hepatic abscess which has ruptured into the subphrenic region must be remembered.

Of ELSBERG'S 73 cases, the total mortality was 40 per cent., and of BARNARD'S 76 cases of subphrenic abscess from all causes the mortality was 47.4 per cent. To these BARNARD added a list of 21 cases operated on by himself, with a mortality of 19 per cent.

The method of treatment recommended by Elsberg is as follows: "About two inches of the ninth and tenth ribs are resected in the usual manner (Fig. 169), somewhere between the scapular and the anterior axillary lines, according as the exploring needle has located the pus more anteriorly or posteriorly. The two ribs can easily be resected through one incision, made in the intercostal space between them (Fig. 170). After the ribs have been resected, the diaphragm, with the liver showing below it, will appear in the lowermost portion of the wound, and the pleural reflection will be seen in the upper part. If there is suspicion that the pleural cavity contains pus, aspiration of the pleura should first be done. If pus is obtained, the cavity should be opened and drained at once. If aspiration of the pleura is deemed unnecessary or inexpedient (as is generally the case), the upper part of the wound should be carefully protected with gauze, and the aspirating needle then made to perforate the diaphragm below the reflection of the pleura (Fig. 172). If the needle enters the abscess cavity, it should be allowed to remain in place and be used as a director. A small incision of the diaphragm alongside of the needle, the dilatation of the small opening with the dressing forceps, and the drainage of the abscess cavity with tubes, according to general principles, are all that is required. The abscess cavity may, however, be situated so near the median line, high up under the dome of the diaphragm, that it can only be reached by the transpleural route. The pleural cavity can then be opened without further delay through the upper part of the wound. In some cases the costo-phrenic sinus has been entirely obliterated by adhesive inflammation, so that the pleura can be incised without opening the pleural cavity proper. If this is the case, great care must be taken not to tear the adhesions, as they are often very weak and easily separated. If the pleural cavity must, nevertheless, be opened it should be done as rapidly as possible. By means of upward pressure against the liver, it is often possible to so closely approximate the diaphragmatic to the costal pleura that little if any air can enter the pleural cavity when the opening is made. Sometimes it is impossible to unite the two pleural layers by suture, and all that can be done is to wall off the cavity carefully with antiseptic gauze."

Diffuse Purulent Peritonitis.—A diffuse purulent peritonitis is occasioned by an infection of lesser intensity existing for a longer time where nature has been able more or less successfully to com-

bat the infection. Pus is found widely distributed, particularly in dependent regions; the intestines are everywhere deeply injected, and, in place of the normal lustrous coat, a shaggy surface is seen, covered with little bits

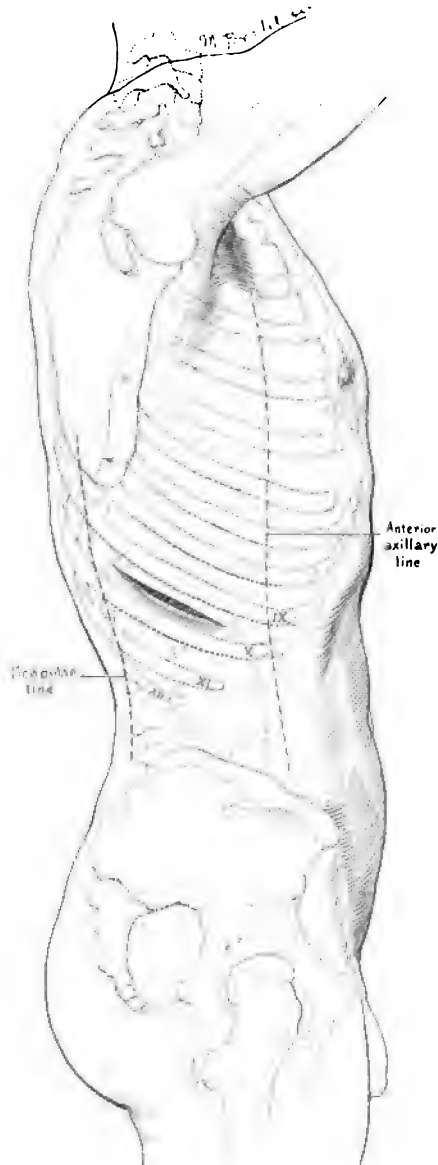
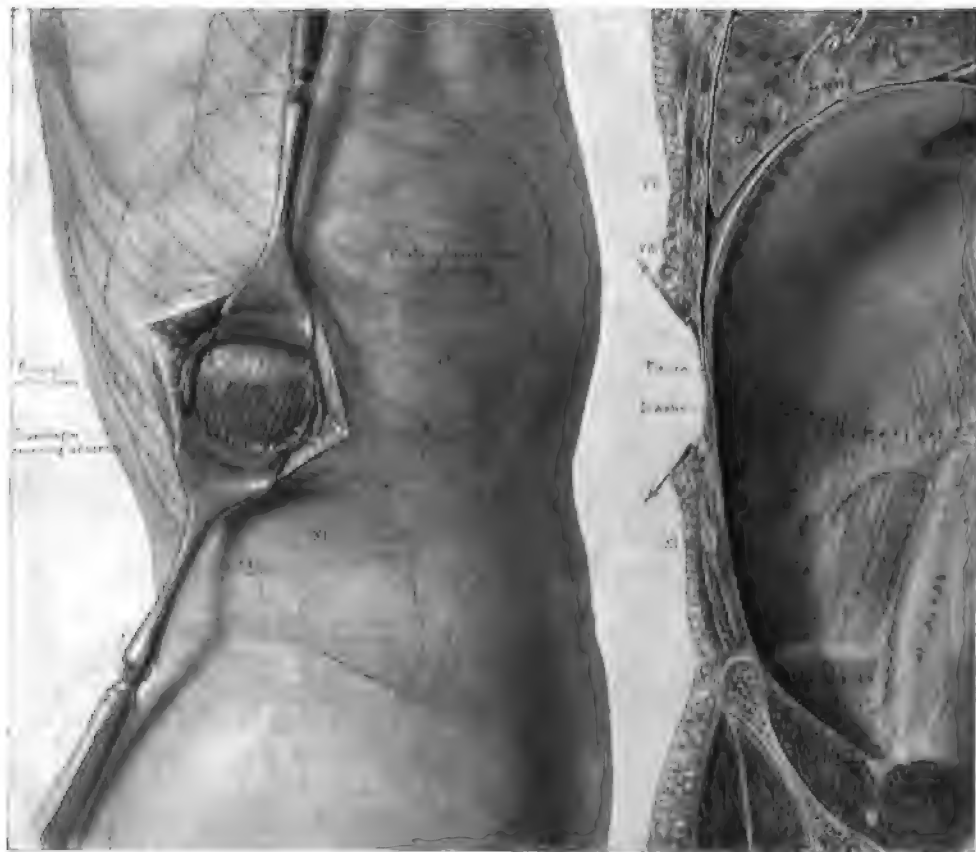


FIG. 169.—ELSBORG'S OPERATION FOR SUBPHRENIC ABSCESS. SHOWING THE SKIN INCISION, TWO INCHES IN LENGTH, MIDWAY BETWEEN THE ANTERIOR AXILLARY AND SCAPULAR LINES BETWEEN THE NINTH AND TENTH RIBS.

of fibrin, often with a capillary vascularization, which float out under water, the coils of intestines are mutually adherent and there is an abundant fibrinous and fibrino-purulent deposit. It is impossible to determine

during life the exact limits of a diffuse peritonitis. The entire area accessible to the eye is more or less involved, the infectious material being distributed over a large extent, and tending, unless checked, to a rapid involvement of the entire peritoneum. The statement that a peritonitis is "general" or "universal" can hardly be made without such a painstaking investigation of every portion of the abdomen as is unjustifiable in the



FIGS. 170, 171.—RESECTION OF ABOUT TWO INCHES OF NINTH AND TENTH RIBS.

The pleural reflection is seen below the costo-phrenic sinus of the pleura. Below this lies the diaphragm covering the abscess. Fig. 171 shows a coronal section of the body revealing the pleural reflection with the costo-phrenic sinus above and with the diaphragm below.

course of an operation. A diffuse peritonitis of this kind is so called in contrast to the circumscribed peritonitis limited to the right iliac fossa, and the disseminated focal peritonitis involving particular areas and shut off from the rest of the cavity by limiting adhesions. A large abscess occupying the entire lower abdomen, and sometimes containing quarts of pus (which is oftenest found in children), is, nevertheless, circumscribed in character. A diffuse peritonitis, on the other hand, may go on to the formation of an abscess

filling the entire abdomen and resulting in abdominal empyema. There is a strong temptation to speak of a case as one of "general peritonitis" when the intestines of the lower abdomen, as far as seen, are found inflamed and covered with deposits of pus in both flanks as well as in the pelvis.

A total peritonitis is one in which the entire abdominal cavity is involved, including the structures above the omentum and the colon, especially in the diaphragmatic regions,

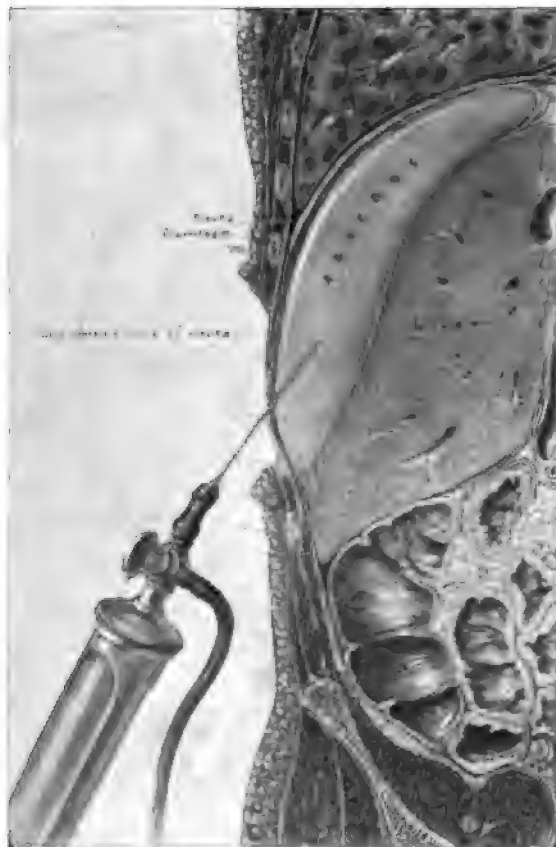


FIG. 172.—ASPIRATING THE ABSCESS THROUGH THE DIAPHRAGM AND BELOW THE PLEURAL REFLECTION.

The operation may be transpleural if necessary when there is fluid in the pleura as well. The aspirator indicates the position of the abscess, which is then evacuated and drained through a free incision. (See p. 350.)

as well as those below. The most acute form of diffuse peritonitis is appropriately termed peritoneal sepsis (WITZEL, "*Diffuse eitrige Peritonitis und peritoneale Sepsis*," *Dtch. med. Woch.*, 1888, No. 40); it being one in which the patient dies with an acute intoxication so soon after the onset of the disease that little or no reactive signs are found in the peritoneum. There is only a slight injection, perhaps a little loss of lustre, and a little fibrin, some bloody serous exudate, and, most important of all, no adhesions setting up a barrier for the limitation of the disease.

DIAGNOSIS.—The diagnosis of a diffuse peritonitis is made by giving close attention to the general character of the abdominal pain and the marked tenderness on pressure. The abdomen is, as a rule, tympanitic, the tympany being a conservative effort on the part of nature to limit the spread of the infection. Once in a while, however, an extensive peritonitis is found in a scaphoid abdomen. The fever is often marked, though sometimes quite wanting. The pulse is small and shows an increased rapidity, often going up to 120 or 140 and even higher, although where the infection is not so severe in character, the pulse-rate may remain nearly normal. One of the most important signs is the persistent distressing nausea and vomiting which generally characterize the affection from first to last, although they sometimes cease toward the end, the cessation producing an illusory impression of improvement. A further most important sign, which is associated with the cessation of peristalsis, is the cessation of fecal movement and the passage of gas. The distended abdomen is fixed, and respiration becomes superior thoracic in type. There is often a dry, typhoid tongue, and later on a mild or marked delirium. As the infection spreads the system becomes dried out for want of water and the excretion of urine is much diminished. There is sometimes an accumulation of ascitic fluid. One of the most marked signs in advanced cases is the facial expression, which is distressed and anxious, the patient having a collapsed look, with hollow eyes and a dusky skin, the expression alone being often sufficient to indicate the nature of the malady to an experienced eye. V. H. WILLIAMS graphically says of one of his cases: "He had that gray, hard, sallow, anxious look of sepsis, which means much to the eye of the surgeon" (*Trans. Amer. Surg. Asso.*, 1893, p. 261).

The first step in the differential diagnosis is to distinguish between these cases of diffuse peritonitis and cases of circumscribed abscess still limited to the neighborhood of the appendix in which the local inflammation has called forth a marked reactive disturbance of the entire peritoneum. In a localized peritonitis there may be fever, quickened pulse, vomiting, and a general tympany of the abdomen, associated with more or less general discomfort. A careful examination, however, will usually show that the tenderness is pretty well localized, and that there is a well-defined mass shut off in the iliac fossa. Furthermore, the effect on the general condition of the patient is not that of the profound depression associated with the more extensive disease. It is in just these cases, however, in which a local affection is passing into a general one, that the most serious mistakes are made, and, where there is doubt, it is better to operate than to wait for the extension of the disease.

The differential diagnosis between *i n t e s t i n a l o b s t r u c t i o n* and peritonitis accompanied with tympany, nausea, and pain, is sometimes even more difficult. In intestinal obstruction however, fever at first is lacking, there is no such widespread sensitiveness to pain as in peritonitis, and the distention is limited to the loops of intestine which lie near to the obstruction. These loops can often be seen and felt as they

contract, and roll their gaseous contents under the fingers in the effort to force a passage through the barrier, the pain being associated with the attacks of peristalsis. Moreover, in intestinal obstruction there is no increasing leucocytosis. In either case relief is to be sought in operative measures.

PROGNOSIS.—The prognosis in cases of diffuse peritonitis depends upon the character of the infection, as well as upon its extent. Where it has spread very rapidly, and there is profound depression as in cases of peritoneal sepsis, there is scarcely any hope whatever may be done. In all cases the prognosis is serious, but in those which tend to run a protracted course with decided local reaction against the infection, there is a chance with operation and none without it. The reaction of the leucocytes should be studied, the blood should be examined and cultures taken to ascertain if there is any marked septicæmia. As soon as pus is reached in the course of the operation, it should be examined microscopically; if *streptococci* are found the prognosis is far more serious than in a more extensive *colon bacillus* infection even though the disease is limited in its area. During convalescence cultures should be made from time to time from the dressings, to determine the kind of bacteria present.

TREATMENT IN GENERAL.—Where it is not possible to operate immediately, the first step in the treatment of a diffuse peritonitis is to put the patient as nearly as possible in a condition of absolute repose. He should lie on his back with his head on a low pillow, and his knees drawn up and supported by a round firm cushion placed under both. He should be so perfectly at rest that he appears as if fused with the bed. Any movement for the purpose of giving necessary attention, such as the use of the bedpan, bathing, alcohol rubbing, etc., should be made with the utmost care. The bowels are best kept at rest ("in splints") by the administration of opium in small quantities, one-half of a grain to a grain by rectal suppositories three times a day. This relieves the pain and checks peristalsis, thus favoring the formation of adhesions and limiting the spread of infection. If the bowels are much distended, morphine, as KORTE says, is better than opium.

A decided elevation of the head of the bed is advisable (see Fig. 98), if not disagreeable to the patient, as it may limit the spread of the infection upward into the most unfavorable part of the abdomen, and determine its gravitation toward the pelvis, where it can be better drained. The patient will be more comfortable if the bedclothes are kept off the body, but if the abdominal walls are thin, hot poultices may give comfort and also be of service in limiting the infection. Ice poultices, if better borne, may be substituted for the hot poultices.

Where there is much vomiting, the washing out of the stomach, which for many years has been tried and found of the utmost service by KUSSMAUL and others, often affords the greatest relief. It should be done with a soft rubber tube, and even though attended with considerable discomfort to the patient, should not be neglected. As a general rule, it is best to give no food or drink, using the rectum as an avenue of alimentation by injecting about 100 cc. of albumen water or pancreatized milk at intervals of six

hours. To give from 100 to 1000 cc. of a normal salt solution twice a day, as recommended by LENNANDER, and widely practised by American surgeons for some years past, relieves thirst, besides improving the pulse and general condition of the patient. Sometimes it is necessary to accede to urgent entreaties of the patient and give a little cracked ice or a teaspoonful of hot or cold water, or, as KORTE advises, a carbonated water. If water is given by the mouth, the occasion may be utilized for administering a little albumen with it. If an operation is to take place within an hour or two, and the bowels are loaded, a warm saline enema should be given in order to evacuate the rectum.

SURGICAL TREATMENT.—It is important in surgical treatment to observe the following rules:

1. To make the operation as brief as possible, consistent with thorough technic.
2. To watch the patient closely, and keep up the vitality during the operation.
3. To remove all septic products as quickly and as completely as possible.
4. To extirpate or to wall off the original focus of the infection, the appendix.
5. To provide abundant avenues for the escape of any further septic material which may accumulate.
6. To relieve excessive tympany.

If the pulse is small, the heart weak, and the patient collapsed, it is well to begin the operation by injecting under the breasts from 500 to 1000 cc. of normal salt solution as the patient goes on the table, the injection continuing during the operation. Hypodermics of strychnine help to keep up the strength and to tide the patient over the shock of the operation. They may be begun with one-thirtieth of a grain, and continued with one-sixtieth, every two hours, until a good reaction is established, and then be kept up at intervals of every three hours or four for several days, unless there are signs of the physiologic action of the drug.

As a preventive against shock, all unnecessary exposure of the body must be avoided, the patient should be kept wrapped in blankets while on the operating table, and hot flasks covered with at least two thicknesses of flannel should be placed under the armpits, at the sides of the chest, and by the legs. Whenever hot bottles are used either on the operating table or in the bed, they should be closely watched to avoid a burn. If a glass and iron operating table is used, it is well to cover it with a quilted cotton pad and, if possible, warm the table with a large tin filled with hot water. If the electric current is near at hand, an electric heater placed in the cotton pad will prevent loss of body heat and obviate shock.

All preparations must be made before the anæsthetic is given; it is best to begin the anæsthesia with nitrous oxide gas followed with ether.

The Incision.—If the abdomen is small and the walls flaccid, it is a good plan to make a liberal incision in the right semilunar line. Where the affection is advanced, and all parts of the abdomen seem uniformly

involved, an incision in the linea alba from the umbilicus to the symphysis affords a still better opportunity for examining all parts of the abdomen, for cleansing the peritoneum, and for making counter-openings for drainage. Good broad retractors are of service in exposing one part of the abdomen after another. The practitioner who has not the advantages of a hospital clinic and well-trained assistants will often find a self-retaining retractor (Fig. 173), which gives a maximum exposure of the abdomen through the wound, of great service while he is mopping out or irrigating the abdomen.

J. ISRAEL (*Verhandl. deutsch. Gesell. f. Chir.*, 26th Congress, Berlin, 1897, p. 15) says that, as it is impossible to empty a generally infected abdomen



FIG. 173.—SELF-RETAINING RETRACTOR.

Saves an assistant by holding the abdominal walls widely apart while the abdominal cavity is being cleansed in general peritonitis. (One-half natural size.)

completely of its purulent exudate, he has been in the habit for some years, in order to limit the harm done by the remaining infectious masses, of making an extensive transverse incision of the abdominal wall (*Kreuzschnitt*) in such a manner as to do away with intra-abdominal pressure, and in this way hinder the absorption of fluid. It is doubtful, however, whether such radical measures are followed by sufficient benefit to warrant their employment.

Lifting out the Intestines.—With the great irregularities and the numerous recesses of the abdominal cavities in mind; it is a strong temptation to the surgeon, in his desire to get rid of all infection, to lift out the intestines and to expose and cleanse them, as well as the emptied abdomen.

This plan has been faithfully tested by some of our best surgeons, notably FINNEY (*Johns Hopkins Hospital Bull.*, 1897, vol. 8, pp. 141 and 143) in a series of experiments upon dogs, which showed a remarkable number of recoveries under this treatment. He therefore advocated the removal of the intestines, which were wrapped in warm towels; the peritoneal cavity was then thoroughly washed out with hot salt solution, and dried with strips of gauze, after which the intestines were cleaned, loop by loop, under a continuous irrigation with salt solution, and finally returned to the abdominal cavity and the incision closed, a small opening being left for drainage. McCOSH (*Ann. Surg.*, 1897, vol. 26, pp. 179 and 687) also recommends removal of the intestines, associating this in suitable cases with incision of the ileum to evacuate gas and fæces, and with the injection of magnesium sulphate into the intestine, followed by closure of the intestines and then of the abdomen. Experience, however, has demonstrated that it is better to refrain from taking out the intestines on account of the profound shock which rapidly supervenes.

The appendix, *the fons et origo mali*, should be clamped off and removed whenever it is possible. If the tissues about the organ are gangrenous, and there is little hope of the sutures holding, the entire area surrounding the head of the cæcum must be walled off from the rest of the abdominal cavity, and drained separately through a liberal incision made at the nearest point in the abdominal wall.

Some successful and interesting efforts have been made to save life by continuous irrigation of the abdominal cavity; for example, E. LAPLACE (*Phila. Med. Jour.*, Oct. 14, 1899) reports "*A case of acute general peritonitis treated by continuous irrigation with normal salt solution*," in which continuous irrigation was kept up for seventy-two hours with beneficial results. VAN LENNEP reported a similar case (*Hahn. Med. Month.*, Feb., 1900) in which irrigation for twelve hours was followed by recovery.

Another form of treatment which calls for mention in connection with that of continuous irrigation, is that of injection of diluted alcohol directly into the abdominal cavity, successfully practised by Z. E. EVANS, of Travers City, Mich. (*Ann. Gyn. and Ped.*, 1893, p. 744). On the third day following an operation for gangrenous appendicitis with diffuse purulent peritonitis, the patient having pneumonia and being very low, three ounces of pure alcohol, diluted with two quarts of warm water, were injected into the abdominal cavity, with the effect of causing the pulse to drop from 140 to 107 and the temperature from 103° to 100° F. Eighteen hours later the process was repeated, with equally good results and ultimately perfect recovery.

DELBET ("*Recherches expérimentales sur de lavage du peritoine*," *Ann. de gynéc.*, 1889, vol. 32, p. 165) has shown that after irrigation for ten minutes the absorptive powers of the peritoneum are so reduced that it is possible to follow the irrigation with a poisonous solution without harm to the animal.

Wiping off the Intestines.—The majority of surgeons to-day prefer to attack an extensive peritonitis by what may be called, in contrast with the method just described, the dry plan of treat-

ment; that is to say, the abdomen is opened, the areas of accumulation of septic material when there are such are exposed, and this material wiped off as far as possible with gauze or sponges. The advantage of this plan is that there is no danger of carrying septic materials into corners where they have not been before, and lodging them there. No one,

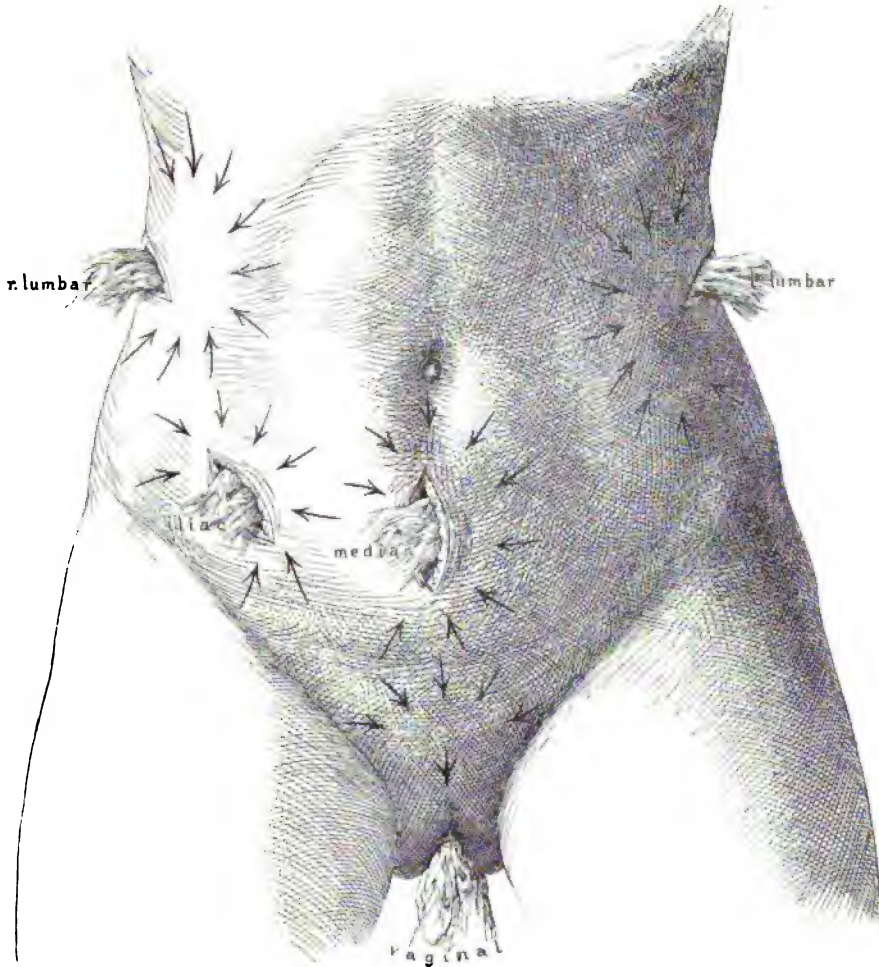


FIG. 174.—SHOWING DIRECTION OF CURRENT FROM THE ADJACENT PORTIONS OF THE ABDOMINAL CAVITY TOWARD THE DRAINAGE OPENINGS IN THE RIGHT ILIAC FOSSA, IN THE RIGHT AND LEFT LUMBAR REGIONS, IN THE MEDIAN LINE AND THROUGH THE VAGINA. IT IS ONLY IN EXCEPTIONAL CASES THAT MORE THAN ONE OPENING IS MADE. The necessity for making secondary drainage holes is almost entirely done away with by setting the patient up in Fowler's position. (See p. 255.)

perhaps, is more emphatically opposed to irrigation than REICHEL, who has expressed himself in the oft-cited dictum that "*die Spülerei der Peritonealhöhle eine Spielerei ist.*"

Under the dry plan of treatment a bunch of gauze or a marine sponge is grasped in a long holder and carried down to the bottom of the pelvis, which is then repeatedly sponged out until clean. A fresh sponge is carried

over into the right and left renal regions; the mesenteric folds are inspected, and the upper and the under surfaces of the liver. A general agglutination of the intestines *in situ* is not a bad sign and under such conditions ought not to be disturbed. In introducing the sponge first into one quarter and then into another, it should be carried up close to the abdominal wall. After drying out the disease without spending much time in picking off plates of lymph, the abdomen is closed, drains being inserted extending either from the median incision down into the iliac fossæ and into the pelvis, or through fresh openings into the sides, and, in women, into the vagina. This line of treatment accords with the recommendation made by TIETZE in 1889 (*Die chir. Behandl. der akut. Periton.*). Necessarily it involves a certain amount of trauma to the gut.

Drainage.—After opening the abdomen, cleansing it of poisonous secretions, and if possible removing the focus of trouble, the appendix, the next step is to provide against further accumulation and absorption of septic material by an efficient plan of drainage. If the patient seems to be almost *in extremis*, and there is a large accumulation in the abdomen to be opened, the surgeon may not be able to do more than make an incision under cocaine, let out as much pus as will escape spontaneously, and insert a large rubber drainage-tube. In less serious cases a gauze drain, whether washed-out iodoform gauze or plain sterilized gauze, acts well for a few hours or a day, but after that time it ceases to affect any area greater than that directly in contact with the gauze itself. The meshes of the gauze then become plugged, and if left *in situ*, it is apt to choke the opening in the abdomen and bottle up the secretions rather than promote their escape. To avoid this ill effect it is well in some cases after the first day to begin to pull the gauze out, and so keep it moving day by day until the whole is removed. The "cigarette drain" used by MORRIS, of New York, and WARREN, of Boston, answers this purpose excellently; it is made up of sterilized gauze, rolled in rubber-tissue, and can be made of any calibre, is soft and flexible, and does not like the unprotected gauze stick to the tissues within, giving great pain with its removal.

Rubber tubing from 6 to 8 inches long and $\frac{1}{4}$ to $\frac{1}{2}$ inch in diameter, introduced and surrounded by gauze, also affords an efficient drain which is not liable to become plugged. If the removal of a drain is painful, a little nitrous oxide gas will overcome the difficulty.

Treatment of the Distended Intestines.—If the intestines are so distended that they can only be returned to the abdominal cavity with difficulty, and if there exists a large accumulation of fluid within the ileum, McCOSH's plan of bringing the loops of the intestine outside, incising, emptying, and then closing and returning the bowel may sometimes be tried with advantage. Where the intestines are paralyzed an *enterostomy* has saved life in numerous instances. This is best executed by keeping the wound open and leaving one of the distended loops as near as possible to the cæcum, exposed in the wound, simply covering it with a pad of iodoform gauze. In order to mark the exact

spot for the opening, two fine black silk sutures may be inserted about 2 cm. apart into the outer coats of the bowel, and left hanging out of the wound. Then after six or seven hours, or more, the dressings are removed, the tissues picked up and held apart, and a small opening about 1 cm. in length is made into the lumen of the bowel, affording exit for gases and fecal material. The attention of the profession has been called to this mode of treatment by W. W. VAN ARSDALE in a paper entitled "*The treatment of the intestinal paralysis of peritonitis by enterostomy*" (*Ann. Surg.*, 1889, vol. 29, p. 1).

CHAPTER XX.

CARE OF PATIENT AFTER OPERATION AND POST-OPERATIVE SEQUELÆ.

CARE OF PATIENT AFTER OPERATION.

ALL is not finished with the completion of the operation. Success or failure still largely depends upon the intelligent, watchful after-care of the surgeon and the nurse: proper attention to many seemingly trivial yet important details during the first two or three weeks following operation will often do much to shorten the period of true convalescence.

The surgeon must always bear in mind that there are two factors in every convalescence, namely, the recovery from the wound and the disease and the recovery of the nervous system from the exhaustion caused by the illness and the shock of the operation. From the patient's standpoint his convalescence is divided into two periods: a first, in which he is confined to bed; and a second, in which he is up and looking forward to complete recovery of his strength and the entire removal of the discomforts left by the operation. During the whole period of convalescence the physiologic economy of the man is actively engaged in striking a fresh balance with his resources, in order that he may once more enter upon the duties of life with renewed vigor.

It is a fond superstition of the laity, often, I am sorry to say, encouraged by physicians, that the convalescent period is shortened by hustling the patient out of bed a few days after the operation; while, on the contrary, it is often lengthened by such treatment. I have seen patients, untimely thrust from the hospital and reported as up "in eight days," who weeks afterward were still feeling miserable and unable to work. It is possible, of course, to get patients out of bed in eight days, and they may do well in spite of this treatment, but it is not to their best interests, and it does not really shorten the convalescent period, which truly ends only when they are able to resume their normal activities with zest.

I also mention, only to condemn, the practice pursued by some surgeons of performing the operation, and then leaving the patient entirely in the hands of a medical man without experience in surgical work. When the case is remotely situated in the country, this may be unavoidable or a choice of evils, but under even these circumstances a trained assistant should either remain behind or make some subsequent visits. It is never justifiable to operate and then abandon the patient, as a compliment to the family physician, who is anxious to enhance his services in the eyes of the relatives. The man who does this is treating his surgery in the light of a trade.

The post-operative period requiring the greatest watchfulness and care extends in the average case over the first five or six days, during the

first two or three of which the patient is getting over the shock of the operation and the nausea caused by the anæsthetic; a day or two longer is required to establish the much-desired regular activity of the bowels.

The signs of a normal convalescence following a surgical operation which is the termination of a protracted illness, are to the anxious bystanders what the rest of a quiet harbor is to the storm-driven mariner. With extreme satisfaction does the surgeon announce to the anxious family the hourly improvement, manifested by the falling temperature, the full, steady, quiet pulse, the decreasing abdominal tenderness and softening of the abdominal walls, the diminution of pain, and the passage of flatus. As improvement progresses, the patient recovers a sound healthy color, his interest in his surroundings quickens, annoying thirst is replaced by a sound, healthy hunger, and the balm of sweet refreshing sleep during the night extends its blessing over the waking period.

If convalescence proceeds uninterruptedly after this manner, the patient may rise from bed in two weeks, but he is wiser if he consents to stay there for three; then for a few days, if the weather permits, he should be wheeled in a rolling chair into the fresh air; a little later still he takes a few steps, and so, in five or six weeks he dispenses with nurses and doctors and is able once more to care for himself.

If the wound is a small one, and especially if the muscle fibres have not been much cut, it is not necessary that the patient should wear an abdominal bandage, which is at best but an awkward contrivance for giving support over the iliac fossæ. Where the wound is extensive, however, and above all where there has been drainage, a snug, supporting bandage should be worn for six months or longer.

NURSING.—It is of the utmost importance that the nurse should be personally acceptable to the patient as well as one well trained in abdominal surgery. In a simple, uncomplicated case of appendicitis one nurse may suffice, but if the patient is critically ill, two, or even three will be required.

Immediately after the operation the patient should be placed in a warm bed carefully prepared. The room must be darkened, the air kept fresh and sweet at a temperature of about 63° F. Absolute quiet must be maintained, and members of the family should, as a rule, be excluded for several days. The first person admitted should be that near relative whose presence is pleasant and comforting to the patient, the rule being imposed that "silence is golden." The surgeon must constantly bear in mind that he has under his care a wound which is healing and a nervous system which is recovering its balance after a severe shock; the latter is longer in recuperating than the former, and nothing so much delays this part of the convalescence as excessive visiting. No outside visitors should be admitted for several weeks.

Posture.—The best posture for the patient is on the back with the knees slightly flexed, but he should be turned occasionally on the right side to rest the tired muscles. The moving must always be done by the nurse.

Sedatives.—Severe pain must be relieved by hypodermics of morphine, say one-eighth of a grain repeated in twenty minutes if necessary, during the first twenty-four to forty-eight hours whenever the pain becomes unbearable. In the case of a child it is best to give one thirty-second to one-eighteenth of a grain every twenty minutes until the pain is relieved. In ordinary cases no morphine should be given after the first forty-eight hours, as its continued use retards recovery; and it may be laid down as a good general rule that the less morphine given, the more satisfactory is the convalescence. In some cases a grain of the aqueous extract of opium in a suppository works better than the morphine, exerting a more direct local influence.

Diet.—All nourishment should be suspended after the operation until the stomach is settled. The first food given should be egg albumen, prepared by beating the whites of four eggs to a froth, and allowing it to stand in a cool place for an hour or more, when the liquid (about 50 cc.) can be drained off, leaving the frothy part behind. It is best to give a teaspoonful at a time mixed in two or three tablespoonfuls of cold water with a little sugar and five or ten drops of lemon juice. It may also be given in ginger ale, in orange juice, or in sherry wine. About the third or fourth day soft food may be given, and after the first week a stronger diet may be gradually resumed. As a rule, attendants are over-anxious to feed patients, who can often stand absolute starvation for four or five days very well. Where the stomach has been much disturbed previous to operation, J. F. MITCHELL has found it of great service to wash it out on the operating table, using abundance of warm water, and continuing until the washings return clear. In cases which suffer from persistent nausea after the operation, with no other ill symptoms, one or two good washings often bring great relief.

CARE OF THE WOUND.—Protection from exposure, and rest are the two important factors in the care of the wound. Protection is best secured by the dressings, held in place by a suitable bandage applied at the conclusion of the operation, in such a way as to cover the right iliac fossa, the groin, the upper right thigh, and the lumbar region. If the bandage is snugly applied, the parts are immobilized, and the formation of a loose sliding plane between the dressings and the body is avoided. An infected wound may easily arise from dressings loosely applied or from those which have worked loose in the convalescence; in such a case every movement of the body, every deep respiration, tends to suck in the air beneath the bed-clothes and to bring gross particles into contact with the incision. To avoid this, the dressings and the bandages must be properly placed, secured if necessary by adhesive straps, and watched subsequently as well, to make sure that they are not loose or slipping upward. To insure rest, the patient must lie in perfect repose during the first days of convalescence, above all avoiding any use of the right leg. All movements must be of a passive nature, effected by the skilled hands of the nurse or of the medical attendant. If all goes well, as shown by pulse, temperature chart, and general

condition, the wound should not be disturbed for from seven to nine days, when all the dressings may be removed with care, and the parts contiguous to the wound cleansed with alcohol and water, or soap liniment, and some fresh lighter dressings applied. If there is a subcuticular wire or catgut suture, it may be drawn out at this time. A few days later all dressings may be removed, and the wound simply covered with a pad of gauze to protect the tender tissues from violence.

If for any reason the patient does badly, if pulse and temperature go up, if the general condition cause any anxiety, or if there is much persistent pain, the wound should always be examined. If it is found to be sensitive, red, and puffy or swollen at any part, it should be opened at once under a little cocaine, and then if pus is found poulticed. It is a mistake to try to let out the pus through a small orifice under these circumstances; the focus of infection, whether just under the skin or lower down, must be regarded as the apex of a pyramid whose base is at the skin surface. It is always unfortunate when the infection extends down into the iliac fossæ to the seat of the operation on the bowel, but if the condition is recognized promptly, and effectively treated by thorough exposure and drainage, the misfortune is limited, after all, to a delayed convalescence, and the risk of a hernia at a later date. Even when the bowel breaks down, and a fecal fistula is established, it is, as a rule, but temporary, and exhibits a remarkable tendency to rapid spontaneous closure within a few weeks.

CARE OF THE BOWELS.—The movement of the bowels gives as much cause for anxiety as any single feature in the average convalescence. When the surgeon has mastered the complications, the appendix has been removed, and the wound well closed, no anxiety need be felt as to the administration of the necessary purgative for moving the bowels. If it is a matter of importance, as it is in some cases of appendicitis, that they should move soon, the plan pursued by J. M. T. FINNEY may be adopted, and about six ounces of a saturated solution of Epsom salts run into the stomach at the conclusion of the operation. The saline given in this way is rarely vomited, and a satisfactory evacuation may be secured as early as eight hours later. In severe cases one or two drops of croton oil may be administered in this way. If purgation is not urgent, a substantial dose of calomel may be given on the second day, followed by an enema in from eight to twelve hours, or broken doses of calomel may be given, say a sixth of a grain every hour, followed by an enema in about eight hours. A teaspoonful of liquorice powder of the German Pharmacopœia answers very well with some patients. BURRELL uses a saline cathartic whenever there is a rise in temperature, a quickened pulse, and a glazed tongue. He gives a saturated solution of salts in tablespoonful-doses, taken in soda water from a siphon, and very cold. This may be repeated from hour to hour. After giving sufficient purgatives and using an enema, it is well to wait from six to eight hours and give nature a chance to act, if the case is doing well in other respects. The bowels will then often move spontaneously and satisfactorily without further stimulus. The doctor and the nurse must

be careful not to let their good judgment fail them through an over-anxiety to hasten the movement; too many or too severe purgatives may leave behind a troublesome diarrhoea.

URINE.—A free flow of normal urine is one of the reassuring signs during convalescence. The urine should be kept, measured, and examined in all cases; if albumen or casts have been found in the urine before operation, it will naturally be watched with greater care during convalescence and the gradual disappearance of these pathologic elements hailed with satisfaction. Kidneys which have been injured by a septic storm are best cared for by promoting a free flow of bland urine, and this is accomplished in most cases by giving a hypodermocleisis of 600 to 1000 cc. of normal salt solution, administered on the operating table, and repeated once or twice in each twenty-four hours for several days.

SEVERE AND FATAL CASES.—The surgeon must always feel that a patient who has strength enough to pull through an operation and live for two or three days afterwards ought to recover unless some unforeseen and unavoidable sequel, such as a metastatic abscess, pneumonia, or embolism, should occur. It sometimes happens, however, that a case which would otherwise recover fails to do so from some defect in technic, not necessarily due to a fault on the part of the surgeon, but arising rather from our still imperfect knowledge as to the best method of drainage, the propriety of draining at all, or some other vital point. The conditions which should occasion anxiety are as follows:

Persistent pain, usually associated with elevation of temperature, is a sign of suppuration in the wound or beneath it, and the local condition should be investigated at once. A quick pulse and persistent nausea, growing worse rather than better, point toward septic peritonitis. A distended abdomen accompanied by vomiting is an indication for the evacuation of the intestinal tract. If auscultation reveals gurgling in cases of paresis it is reassuring evidence of intestinal activity, showing that the intestines are capable of performing their normal functions.

Psychic disturbances, such as great restlessness, persistent painful wakefulness, or too eager assurance of recovery, are often associated with profound septic troubles. They should be combated with mild sedatives, such as bromides, trional, heroin, etc.

POST-OPERATIVE SEQUELÆ.

INTRODUCTORY.—It is an unfortunate fact that the conclusion of an operation does not invariably terminate all anxiety as to the patient's recovery. Oftentimes the operation, especially if it has been difficult, is followed by a more or less stormy convalescence, interrupted, it may be, by sequelæ which seriously threaten life itself.

Many of these disturbances are common to all major surgical procedures in which an anæsthetic has been used, such, for example, as nausea and vomiting, hiccough, extreme nervousness, exces-

sive pain, sleeplessness and mania. Other sequelæ are those more peculiarly associated with lower abdominal operations, especially such as involve infected areas,—*e. g.*, peritonitis, abscesses forming in or underneath the wound, ileus, phlebitis, pneumonia of embolic origin or septic pleurisy.

The character of the post-operative sequelæ is apt to vary according as the case has been simple or difficult, and for this reason it is possible to anticipate certain evils according to the nature of the preceding illness; for example, after a simple removal of the appendix, only such disturbances are apt to arise as affect the earliest period of convalescence, *e. g.*, tympany from atony of the bowel or pain arising from a simple traumatic peritonitis. After a more serious operation, in which, for instance, an abscess has been opened or the peritoneum has been soiled, the anxiety of the medical attendant during the first few days of convalescence is concentrated upon those symptoms which point toward a fresh accumulation of pus, to a spreading peritonitis or an intestinal obstruction. The best guarantee against the onset of serious symptoms during the convalescent period is the correct performance of every step of the operation, and the recollection of having done this is a source of great comfort to the operator. Careful work and painstaking attention to detail are the best prophylactics against accidents during convalescence, and many of the most serious post-operative sequelæ may be obviated by these means. Moreover, the peculiar difficulties of an operation often throw light upon the possible sequelæ and suggest means of obviating them. If, after closing the stump, it is well embedded in the cæcum, it will not then contract adhesions with the bowel or omentum. By avoiding undue handling of the intestines and the adjacent peritoneum the delicate epithelium is spared abrasions, and traumatic peritonitis with adhesions will, to a large extent, be avoided. In using a retractor, great care must be taken not to bruise the iliac vein; as this precaution insures against one prolific cause of phlebitis. By thorough cleansing of abscess cavities and the freest possible drainage, the necessity of opening them again at a later date will often be obviated. Secondary operations will also be avoided if the surgeon is careful at the time of the first operation to locate other abscesses in the pelvis, among the intestines, or in the flanks, and to drain them in their most dependent portions. An extension of peritonitis by the extravasation of fæces a few days after the operation will be avoided if torn and sutured intestinal areas are brought out with less hesitation than is usual, and left exposed to view in the open abdominal wound. When an operation is undertaken for an ileus, the surgeon will often be spared the mortification of repeating it if he examines carefully all the adjacent coils of intestine to make sure that he has not overlooked any important adhesions. Hernia is best avoided by operating early, before the advent of such symptoms and complications as necessitate drainage of the wound, that is to say, by a very early operation or by one in the interval.

If we look at these sequelæ according to their relation in time to the original operation, we may conveniently divide them into early, intermediate, and late.

Early sequelæ are those associated with the anæsthetic, the nervous condition incident to the operation, and the continuation of those disturbances which are projected forward into the time of convalescence from the pre-operative stage, such as the extension of a peritonitis.

Intermediate sequelæ are those which begin a few days to a few weeks after the operation, and are caused by the evolution of an abscess, by an ileus, the formation of a phlebitis, or the lodgment of an embolus.

Late sequelæ, which may arise months or years after the original operation, are hernia in the scar and intestinal obstruction.

HOMER GAGE reports that out of 228 cases operated upon for appendicitis whose subsequent history he was able to trace (in many of which the abscess was simply drained), 42 made complaints of one sort or another on inquiry. Out of 54 cases there was a recurrence in 10 per cent. In a number of instances, however, the replies indicated that the complaints were of long standing, and not post-operative. Thirteen complained of more or less discomfort in the region of the scar; of soreness caused by exercise; of pain on the approach of a storm; of a weakness noticeable most of the time. Every operator is familiar with the complaint of persistent pain in the neighborhood of the wound, and the assertion that the discomfort is the same as it was before the appendix was removed. Some of these discomforts are caused by the large, tender scar; some undoubtedly are due to the injury of nerve fibres during the operation; others to a localized peritonitis and adhesions about the head of the cæcum. One of GAGE's cases was a young school-teacher, whose appendix had been removed in the interval, and who experienced such severe pain in the region of the scar, with tenderness over the upper end, that she had to give up her work and go to bed. On reopening the abdomen an adhesion of the omentum was found, about half an inch square. This was liberated, and the relief was immediate and complete, all pain and tenderness disappeared and she was able to resume her occupation. In another case a woman, thirty-five years old, complained of great soreness and tenderness in the region of the scar, which was excised and freed with equal success; some omental adhesions also were freed.

Sometimes the pain in the iliac fossa simulates the old attacks of appendicitis, but this, for the most part, wanes steadily, and disappears after some months or a year. In one case, however, occurring at the Johns Hopkins Hospital, a man had such definite attacks following operation that it was at last thought the appendix could not have been removed. On a second operation, however, there proved to be nothing at the site of the organ but adhesions.

One of the most troublesome sequelæ is an area of anaesthesia over the lower abdomen at some point between the scar, the median line,

and the symphysis. This is due to the injury done by division of the sensory nerve fibres, and is best avoided by a careful dissection with blunt separation of the tissues, the nerve trunks thus being spared. The division of the nerves entering the rectus muscle across the semilunar line is often responsible for a marked atrophy of the muscle and a thinning of the abdominal wall. This serious accident is also easily avoided by duly respecting the nerves when the tissues are divided in opening the abdomen. (LENNANDER.)

HEMORRHAGE.—A post-operative hemorrhage may take place from some vessel large enough to cause a serious loss of blood, which may have been perfectly controlled during the operation by the crushing power of the clamp. A warning example of this contingency is frankly furnished by R. L. PAYNE, of Norfolk, Virginia, who, when operating upon a child, divided and clamped the epigastric artery while making the abdominal incision, and in the anxiety and hurry attendant upon a difficult operation, no ligature was applied, as there was no bleeding when the clamp was removed. The wound had to be drained, and when the hemorrhage occurred, although there was every opportunity for the nurse to call the surgeon, she did not do so until the patient had bled to death, when all the dressings and the bed were found saturated with blood.

SIR DYCE DUCKWORTH (*Med. and Surg. Trans.*, 1889, vol. 72, p. 433) operated upon a boy of sixteen for the removal of an appendix which was gangrenous for two-thirds of its length. The patient did well for eight days, when he began to have pain in the region of the wound, for which half a grain of the extract of opium was administered. As the pain continued to increase, the dressings were removed and a large blood-clot was found; this was removed, but the source of the hemorrhage could not be discovered. The drainage-tube in use was then replaced by a plug of iodoform and lint, and the wound tightly bandaged. In the afternoon the wound was dressed, and a quantity of dark, clotted, and grumous blood removed; recovery followed.

WALCH (Havre), under the title "*Hémorrhagie intestinale grave à la suite d'une opération d'appendicite à froid*" (*Bull. et mém. de la Soc. de Chir. Paris*, vol. 27, p. 374), cites a case in which he resected the appendix in a man forty years old, three months after an attack of appendicitis. He placed a ligature around the base of the appendix, but did not cover the stump with the serosa. Three days later the temperature rose, and the man developed an undoubted right-sided pleurisy. Six days after the operation he became suddenly worse, and suffered from tenesmus, followed by the sudden discharge of an enormous quantity of blood from the rectum; in addition to three litres discharged in this way, he vomited about 300 to 400 cc. of blood mixed with the contents of the stomach. WALCH believed that the bleeding proceeded from the site of the operation, on account of the manifestly arterial tint of the blood, and he considered that the hemorrhage arose from the slipping of a ligature. The patient recovered with no more serious disturbance than the great fright.

In order to avoid a secondary hemorrhage of this nature it is best to tie all large vessels as soon as they are divided, especially those in the deeper layers of the wound, and in the peritoneum. It is also well to sterilize all sloughing areas over the iliac vessels by cautiously applying a little pure carbolic acid, at once neutralized by alcohol. Any serious hemorrhage ought to be controlled temporarily by the compression of the internal iliac artery, or even the abdominal aorta, until the arrival of the surgeon, when the whole wound must be opened up and cleansed, the bleeding points being exposed and ligated. Hemorrhage from the little vessel in the wall of the appendix or from the cæcum can be obviated by the ligation of the artery of the mesenteriolum down in the angle near the colon by crushing the stump or by cauterizing it.

SUPPURATION OF THE ABDOMINAL WOUND.—In removal of the appendix, as well as in other abdominal operations where there is an antecedent infection, there is a liability to suppuration of the abdominal incision, which may seriously disturb convalescence, although grave fears for the safety of the patient do not arise until the nature of the trouble becomes evident. This disturbance usually manifests itself in four or five days or perhaps a week after the operation, when the patient, who has been doing well, or who has had at most a slight and inexplicable rise of temperature for a few days, begins to complain of a pain, often definitely localized, the temperature goes up to 102° F. or even higher, and there is sometimes a pronounced chill. The aspect of the wound, hitherto favorable, now takes on the appearance characteristic of a localized infection with suppuration. In all cases with such a history, attention should first be directed to the condition of the wound. The dressings should at once be removed and the incision carefully inspected; if it is infected, the edges will be reddish and pouting from puffing of the skin at some definite point, or else all along the wound; or induration, slight swelling, or tenderness may be discovered at some point on palpation. In such a case the diagnosis is clear, and a little gas should be administered as soon as possible, after which the edges of the incision are drawn apart and the infected area laid widely open, cleansed, drained, and then allowed to heal by granulation.

GAS FORMATION.—H. L. BURRELL (*Bost. Med. and Surg. Jour.*, May 2, 1894) reports three instances of this condition, in which, on the tenth or twelfth day after removal of the appendix, and after the temperature had become normal, its sudden and continuous rise, accompanied by chills, obliged him to open the wound. On separating the intestines, the escape of a large quantity of gas took place, causing a bystander on one occasion to remark that there must be a perforation of the bowel. No opening was found however, and in every case the temperature fell to normal as soon as the wound was packed, the patient making a complete recovery. In the absence of other reports of a similar post-operative sequela, it must be concluded that some special local cause temporarily associated with the operator had been at work in these cases.

GANGRENE OF THE WOUND.—In badly infected cases, contamination of the wound at the time of the operation may result in gangrene affecting the exposed muscles, the fat, and the skin; it is manifested by redness, infiltration, fever, local pain, odor, and the appearance of sloughs. The proper management of such a condition consists in the freest possible exposure of the entire affected area, and its daily treatment by cutting away the dead tissues, cleansing with peroxide of hydrogen, and disinfecting the area with a poultice of Labarraque's solution (sodium carbonate 10, chlorinated lime 8, water to 100) made up with flaxseed meal, or corrosive sublimate 1 : 1000. Instead of this, or alternating with it, a charcoal poultice may be applied.

ABSCCESS.—Sometimes, but fortunately in rare instances, a small localized suppuration will take place in or about the head of the cæcum, which, becoming encapsulated by adhesions and an adherent omentum, remains indefinitely *in situ*, giving rise to pain and local discomfort which is apt, sooner or later, to necessitate a secondary incision. A suppuration within the peritoneal cavity may be also lodged in some other part of the peritoneum, as, for example, in the right lumbar region, in the pelvis, or among the intestines. Suppurations at a distance from the wound, although discovered at some date subsequent to the operation, are not properly to be classed among the sequelæ dependent upon the operation itself. We shall, therefore, consider only the local suppurations in contiguity with the wound.

Sometimes an infection starting in the neighborhood of the amputated appendix or under the cæcum develops slowly and becomes completely walled in, giving rise to symptoms of infection and local discomfort, more or less resembling the original attack of appendicitis. Such a case occurred in the practice of T. S. CULLEN (*New York Med. Jour.*, 1902, p. 1111. See Figs. 175 and 176).

In a case of my own, the removal of a very adherent appendix, in which there was no trace of infection, associated with an extensive and difficult enucleation of adherent pelvic viscera, was followed by the development of a localized infection behind the cæcum. The abscess was promptly opened, when it discharged about 30 cc. of a milky, watery fluid. There was no general peritoneal infection, but the patient died subsequently from obstruction due to general adhesions among the small intestines, which had been associated with inflamed pelvic viscera.

EPIDIDYMITIS.—A. WORCESTER, of Waltham, Mass. (*Boston Med. and Surg. Jour.*, Aug. 4, 1898), gives a case of epididymitis in a boy ten years of age, which supervened after the opening of an abscess in the right iliac fossa and in which several ounces of thick pus escaped and a sloughing mass was found which resembled the appendix.

CANCER IN THE WOUND.—RICHARDSON and BREWSTER cite a case of cancerous infiltration of the whole ileocæcal region occurring a few months after the removal of a chronically inflamed appendix at the Massachusetts General Hospital (*Bost. Med. and Surg. Jour.*, July, 1898). It is probable that a small cancerous appendix had here given rise to an early perforation

with extension of the disease beyond the organ removed, and that its true nature was overlooked. Such a case has been discovered in the pathological laboratory of the Johns Hopkins Hospital by E. HURDON.

PYELITIS.—I have seen one instance of infection of the right kidney as a sequela to an operation upon an inflamed appendix, and this was the case of a physician whose appendix was removed at another clinic in June,



FIG. 175.—CULLEN'S CASE. THE APPENDIX HAD BEEN REMOVED TWO YEARS BEFORE.

At the second operation the omentum was found adherent over the outside of the cæcum, and behind this lay the small abscess (a).

1900. His bladder and upper urinary tract were apparently infected by the attendant who catheterized him, and a persistent pyelitis followed. This was not relieved until I did a nephrotomy and drained the kidney on the fifth of July, 1900, an operation which was followed in a few weeks by a complete and permanent recovery. WILLY MEYER (*Med. Rec.*, Feb. 29, 1896) reports the case of a young woman who, "after complaining of pain in the right groin for eight days, developed symptoms of a most acute peritonitis." At operation the appendix showed an acute catarrhal inflam-

mation, but no gangrene or perforation, as had been fully expected; neither was there a fecal concretion nor any adhesions, but the neighboring peritoneum was highly hyperæmic and the true pelvis contained seropurulent fluid. The wound was left widely open for drainage, and the patient hovered between life and death for five days with symptoms of acute sepsis. On the twentieth day after the operation, when her temperature and pulse for the first time were normal, fever set in with pain in the left renal region,



FIG. 176.—SAME AS PRECEDING, SHOWING ABSCESS (x) EXPOSED BEHIND CÆCUM. (See p. 371.)

and the urine, which up to this time had been slightly turbid, suddenly became clear. A diagnosis was made of obstruction of the ureter by pus and clotted blood, due to an abscess of one of the pyramids of the kidney. The difficulty was suddenly relieved by the reappearance in the urine of a heavy, bloody, purulent deposit. Three weeks later the urine was normal and the patient recovered.

CYSTITIS.—Inflammation of the bladder, due to neglect in allowing overdistention, or to defective catheterization, or often in spite of every precaution, is a frequent sequela to operations of all sorts, including appendicitis. Cystitis would be discovered more often than it is if cultures were

habitually taken whenever the patient makes the least complaint of dysuria, but, as it is, the lesser grades of disturbance of the urinary system are rarely observed, owing to the general neglect of this practice. In my private hospital it is my invariable custom to draw a little urine when the patient is brought on the operating table, and make cultures from it. In this way the presence of infection is often demonstrated before operation. Dysuria, and perhaps cystitis, will be noted much less frequently in the convalescence, if the practice is generally followed of administering a saline enema in all simple cases, while the patient is still upon the operating table. Some surgeons prefer, instead of this, to give urotropin beforehand in five or ten grain doses three times a day.

AUTO-INFECTION (ACETONÆMIA).—G. E. BREWER has reported a fatal acetonæmia following an operation for acute appendicitis (*Ann. Surg.*, Oct., 1902). Acetonæmia is a form of auto-intoxication characterized by a well-marked sweetish odor of the breath, by delirium, and by a rapidly fatal coma. The odor, which is sometimes faint and scarcely appreciable, and in other cases strong enough to fill the room, is that of acetone, and is compared by some persons to a pippin apple, and by others to chloroform. Acetonuria was at first recognized only in fatal cases of diabetes, but has now been shown to occur in infectious fevers, in general sepsis, in intestinal fermentation, and in putrefactions, etc. Acetonæmia constitutes a form of acid intoxication, or "acidosis," which results in a marked diminution in the alkalinity of the blood, diminishing its power of absorbing carbon dioxide from the tissues, so that the clinical signs are due to a carbonic acid poisoning as well as to the acetonæmia.

The treatment employed in BREWER's case was the rational one of the abstraction of 400 cc. of blood followed by the infusion of 1000 cc. of normal salt solution containing about 15 gm. of pure bicarbonate of sodium, in addition to purgatives by the mouth and saline irrigation by the rectum. BREWER gives the following test for acetone: Place about 20 cc. of the urine in a small glass retort, heat over an alcohol flame, and condense the vapor in a test-tube; then add a small amount of potassium hydrate to render the reaction alkaline, after which add four or five drops of Gram's solution of iodopotassic iodide and heat gently. If acetone is present a strong iodoform odor will be perceived and yellow crystals will form in the tube.

NERVOUS SEQUELÆ.—The nervous sequelæ following an operation for appendicitis do not differ in any way from those attending other grave operations. They vary in character and are more or less intense according to the temperament of the individual and the gravity of the disease. Profound nervous disturbances are apt to arise after previous exhaustion from a protracted illness or where there has been undue excitement at the prospect of surgical interference, and when the shock of a grave operation is added to these factors, we need seek no further to discover adequate cause for nervous sequelæ. Something can be done in the way of prophylaxis to obviate these most distressing conditions, by calming the patient

beforehand, gaining his confidence in his physician and surgeon, and avoiding detailed and picturesque descriptions of the necessary surgical procedures in his presence. Whenever possible, the anæsthetic should be gently and quietly given, with the full consent of the patient, and should be administered in his own bed or in a room adjoining the operating room, entirely undisturbed by the bustling preparations for the operation. It is better to defer the proceedings than to begin the anæsthesia under compulsion and against struggles. I would also insist on the importance of making the anæsthesia as brief as possible in cases where the patient shows marked signs of nervousness. Much can also be done, according to H. A. HARE, in the way of prophylaxis during the early convalescence by relieving pain and securing some hours of refreshing sleep during the twenty-four by the administration of hyoscyamine sulphate (one-fiftieth of a grain) or even a little morphine hypodermically.

Mental disturbances have been reported, varying in degree from slight transient confusion to violent mania, as in a case reported by G. G. CORTAM (*St. Louis Med. Rev.*, Sept. 15, 1894). The patient, a farmer's wife, thirty-seven years old, had an appendix removed, which was incarcerated by bands of organized lymph, and on account of the extensive handling of the tissues a gauze drain was left in. On the third day after, after moderate elevation of temperature and increase of pulse, "acute maniacal delirium with high temperature abruptly followed, the patient making frantic attempts to bite, scratch, kick, and otherwise injure those who tried to restrain her." Death shortly closed the scene. W. H. DOUGHTY, of Augusta, Ga., related to me the case of a delicate girl about sixteen years of age, who had been worked hard at school, was nervous, worried, and cried easily. At the operation for an acute appendicitis the appendix was found swollen, but not perforated, with a few drops of pus on its outside. The wound was drained, and the patient did perfectly well for three days, having no fever, when suddenly at two o'clock in the night, sixty hours after the operation, she awoke screaming and in violent mania, which continued until her death forty-eight hours later. Her pulse rose to 160 and her temperature to 105° F.; she bit her mother on the cheek, and fought and scratched all who came in contact with her. No peritonitis was found at the postmortem and the area of the wound was perfectly walled off by the gauze. The symptoms of these two cases are exceedingly suggestive of an acetonæmia, as observed by BREWER, and it is plain that all our cases of mental disturbance and mania following operation must be subjected to a more systematic investigation from this stand-point.

A dry cough or a hiccough, trifling ailments in themselves, may cause extreme distress when associated with a recent wound, on account of the uncontrollable contractions of the abdominal muscles. Minute doses of morphine may be necessary here to bring relief. The superficial use of the actual cautery over the epigastrium will often stop the hiccough, and a mustard plaster over the chest will sometimes relieve the cough. In a bad case it is a good plan to give inhalations of the compound

tincture of benzoin, prepared by pouring a pint of boiling water on a drachm of the drug; the vapor from this is then inhaled through a funnel-shaped tube; tincture of opium may be added to it.

BRONCHIAL CATARRH.—A bronchial catarrh is best avoided by operating in a warm room, and by keeping the patient warm during the preliminary preparations, as well as during the operation. As little anæsthetic as possible should be given, especially if ether is used. When the condition occurs, the envelopment of the chest in an extensive mustard plaster has been found an effective agent in relief.

PLEURISY.—A pleuritis is usually a sequela to the graver forms of appendicitis, such as the perforative and the gangrenous. It may vary in degree from a light transient form, recognized only by the pain and a slight friction sound, to an extensive exudate filling the right chest and compressing the lung, which ultimately becomes purulent and emits a foul fecal odor due to the colon bacillus. The severer forms of pleuritis are often associated with other suppurative foci within the abdomen. Pleuritis of this description has been particularly studied by L. LAPEYRE (*Rev. de chir.*, 1901, tom. 23), who, following DIEULAFOY, describes from an etiologic standpoint two distinct forms of pleurisy. The first has its origin in a pyæmic infection in which the infecting organisms enter the circulation by emboli and are carried to the pleura, where they may cause infarcts similar to those so well known in the lungs and kidneys. This kind of pleurisy is very rare and is associated with such marked disease that it has little clinical importance, most frequently gaining recognition on the autopsy table. The second form, which is distinctively an appendical pleurisy, is simply an abscess of the pleura resulting from direct extension of the infection through the diaphragm to the appendix. The pyæmic form occurs with equal frequency on either side, but the appendical form is always found in the right pleura. LAPEYRE insists that appendical pleurisy is always preceded or accompanied by a focus of suppuration under the diaphragm (subphrenic abscess) of which it is but the terminus. He lays great stress upon this fact, and holds that the theory of a propagation of the pleurisy from a septic focus at a distance by means of a suppurative lymphangitis, as described by PIARD and DIEULAFOY, must now, in view of many clinical facts, be given up ("*elle . . . ruine la théorie de la pleurisie à distance par lymphangite pleuro-pariétale*").

The symptoms of a right-sided pleurisy are: fever, quickened pulse, rapid respiration, and often pronounced sweats with sticking or stabbing pain in the lower thorax or at a point near the shoulder-blade; there are friction sounds in the early stages, and later on, dulness on percussion, extending gradually upward, even as high as the fourth interspace; the liver is frequently pushed down, there is tenderness on pressure over the thorax and sometimes œdema of the chest walls. A hollow needle may be used to make the diagnosis certain. It is important in all such cases to bear in mind the likelihood of suppuration within the abdomen, sometimes in the neighborhood of the ascending colon, sometimes under

the liver and almost always above the liver and below the diaphragm. The intra-abdominal focus of infection is sometimes so completely masked by the extensive pleuritic effusion that the surgeon may wholly fail to recognize the source of a purulent pleurisy until he has opened and evacuated it. It has happened in a number of instances, especially in children, that an appendicitis has been recognized for the first time after opening the chest to evacuate the pleura.

Treatment.—The best prophylactic treatment consists in the free drainage of the retrocolic abscess, or in the early recognition and drainage of a subdiaphragmatic abscess. In the event of the formation of a pyæmia of the pleura, the surgeon should take prompt steps to secure good drainage. If the accumulation is a small one, an opening may be made in the intercostal space in front of the posterior axillary fold, between the seventh and eighth or the eighth and ninth ribs, a little external to the angle of the scapula. The incision should be about two inches long, just above the rib. When the pleura is opened, it should be thoroughly washed out, wiped as far as accessible, and then drained.

In cases in which the collection in the pleura is serous in nature, entire relief may follow a simple aspiration. Where there is a considerable collection of pus, the better plan is to resort at once to the resection of a rib: this proceeding gives abundant room to explore, to cleanse, and to drain the infected space. As the resection is done under the periosteum, the intercostal vessels and nerves are not injured, and the integrity of the rib is restored after the necessity for drainage is done away with. An incision is made over the ninth rib, rather posteriorly, in order to secure good drainage, as the patient lies in bed. The costal periosteum is then divided, elevated, and peeled back from the bone on all sides, the groove at the posterior inferior surface being included. After completing the periosteal detachment, the denuded bone is removed with bone pliers or a small chain saw. When the pleura is exposed, a hypodermic syringe may be used to locate the pus, which is then drained off slowly through a small opening so as to avoid syncope. The empty cavity should now be washed thoroughly clean of pus and lymph, great care being taken not to use undue pressure in irrigating. The next step is to introduce a good-sized rubber drainage-tube, which is kept from slipping out by sewing it to the skin with a couple of silk sutures. The wound is then swathed in handfuls of loose gauze handkerchiefs, kept in place by straps and a bandage. As the cavity closes and the discharge grows less, the condition of the patient improves. If the drainage is not satisfactory, a counter-opening may be made at a more dependent point between the two ribs by carrying an instrument into the original opening and using it to push the pleura forward while the operator cuts down on its point. A rubber drainage-tube may then be inserted from one opening to the other. This secondary operation can be done under cocaine anæsthesia.

LUNG COMPLICATIONS.—The subject of lung complications following operations for appendicitis is one of peculiar interest to the pathologist as

well as to the clinician and the surgeon. Interest in it began with the studies of the phenomena leading to the formation of a thrombus in intravascular coagulation; phenomena closely associated with the name of VIRCHOW, who attributed the greatest importance in the process to the retardation of the blood-current, and of BRUCKE, who drew especial attention to the alterations taking place in the walls of the vessels; the interest being further sustained by the studies of COHNHEIM and of EBERTH-SCHIMMELBUSCH on the organization of the thrombus. From thrombus to embolus is a natural sequence. GERHARDT showed the character of the hemorrhagic infarct in a paper entitled "*Der hämorrhagische Infarkt*" (*Volkmann's Samml. kl. Vortr. f. inn. Med.*, No. 31). GUSSENBAUER demonstrated that the pneumonias so often observed after the release of an incarcerated hernia were always embolic in origin. It has only recently been shown, however, that the pneumonias, and also many of the pleurisies, following operations of all kinds are due to thrombosis and embolism. For a complete exposition of the subject see WELCH's article in *Allbutt's System of Medicine*. A valuable article has also been written by A. OPPENHEIM, utilizing SONNENBURG's material, entitled "*Lungenemboilen nach chirurgischen Eingriffen mit besonderer Berücksichtigung der nach Operationen am Processus Vermiformis beobachteten*" (*Berl. klin. Woch.*, Feb. 3, 1902, p. 94).

Frequency.—HOMER GAGE (*Bost. Med. and Surg. Jour.*, 1907, vol. 156, p. 464) says that abscess of the lung and pleural empyema are not infrequent sequelæ of acute appendicitis, estimating their frequency as two to three per cent. of all suppurative cases. He thinks that the sources of infection are apt to be overlooked in these cases, and that the infection may spread by a true metastatic process. In a study of 1000 cases of appendicitis, SONNENBURG found lung complications in 5 per cent. (*Archiv f. klin. Chir.*, 1902, vol. 68, p. 468). All of these cases were in the public hospital at Moabit, and in this group thrombosis and embolism were observed 17 times, while in 260 cases occurring in SONNENBURG's private hospital the same complications occurred 19 times. According to him, the discrepancy between the two sets of figures is due to the difference in the class of patients treated in the two hospitals. LOUIS DRUAIS (*Thèse de Paris*, 1906) has collected 12 cases of pulmonary embolism with sudden death following operations for appendicitis, and 16 cases of the milder form of embolism. He considers pulmonary embolism more frequent in the appendicitis cases which are complicated by an abscess or adhesions; the diagnosis is apt to be confused with lung complications due to the anæsthetic. Of the milder forms, that is to say, those not rapidly fatal, the more serious are those emboli which become septic.

Etiology.—A pulmonary embolus following an operation on the vermiform appendix is a sequela to a thrombus previously formed in the pelvic or femoral veins. Small emboli may form in the vessels of Retzius which traverse the outer surface of the cæcum and enter the lumbar veins; it is also possible for an embolus to pass into the heart by the portal anastomosis with the cava. For practical purposes, however, the

sole source of pulmonary emboli lies in the tributaries of the common iliac veins. The pathologic chain, whose last link is the pulmonary arterial branches of the lung, consists of the following individual links: an appendicitis, an operation, the formation of a thrombus in the adjacent veins, the detachment of the thrombus, its journey through the iliac veins and upward through the vena cava into the right heart, its transit through the auricle and ventricle into one of the pulmonary arteries out into the lung, where it lodges as an embolus which gives rise to a hemorrhagic pulmonary infarct. Cases of embolism without operation are almost, if not quite, unknown.

Symptoms.—The attack comes on in one to four weeks after the operation, and it may come on when the patient is first up and about, being especially apt to occur during some act of exertion, especially straining at stool. The patient feels a severe pain in the pelvis due to the detachment of the thrombus, or in the back or shoulder from the lodgment of the embolus. The pulmonary pain then increases in intensity, and there is evidence of air hunger, the patient becoming cyanotic or lead-colored, while the respiration is embarrassed and rapid. There is great mental distress and apprehension with profuse sweating and sometimes vomiting, the heart becomes feeble and irregular in action, and the pulse is small and quickened to as much as 140 a minute, or, it may be, disappears altogether. As a rule, there is slight elevation of temperature, but the fever is not usually high and never runs the course of an ordinary pneumonia. There is pain in breathing and a slight pleuritic exudate may be noted. After a day or two, when the infarct has formed, there is characteristic bloody sputum, a few cubic centimetres at a time. The thorax is sometimes excessively sensitive, even to the stethoscope, which reveals râles and an absence of the regular respiratory sounds.

Diagnosis.—A pulmonary embolism may be mistaken for a pleurisy on account of the intense stabbing pain in the chest, associated with embarrassed respiration and a moderate elevation of the temperature. There can be no doubt, as shown by G. B. MILLER (*Amer. Med.*, 1902, vol. 4, p. 173) and by DRUAIS, that most of the so-called pleurisies which follow abdominal operations are due to emboli of medium size. The diagnosis of an embolus, however, can be made by noting the cardiac embarrassment, the quickened respiration and pulse, with slightly increased dulness on percussion, and, later, signs of hepatization. The fever, as stated, is slight, and is never pneumonic in type. The characteristic bloody sputum from the infarct appears in twenty-four hours. Slight attacks are often recognized by their tendency to repetition. There is no doubt that if close attention is paid to all complaints referred to the thorax, the diagnosis of embolism will be made much more often in the future.

Treatment.—Much may undoubtedly be done in the way of prophylaxis by avoiding all injury to the pelvic veins in the course of the

operation on the appendix. If an adherent appendix crosses the iliac vein, it will often be better to strip the inner coats of the appendix out of the outer coats, so as to avoid injuring the vein. Especial care must be taken to avoid the formation of the parent thrombus; if, however, a thrombus is known to have formed, all active exertion or straining, especially at stool, must be sedulously avoided. After the embolic attack the patient must be kept as nearly as possible in absolute rest, if necessary with the head and shoulders elevated. Small hypodermic doses of morphine repeated at intervals do much to compose the mind and quiet the action of the heart. As pointed out long since by GERHARDT, digitalis is dangerous and should never be given. The responsibility of the physician is heightened when the patient has had one attack; he must then guard with the utmost care against the slightest exertion, insisting upon complete quiet and absolute rest until the infarcts are absorbed and all thrombi organized or absorbed. Oxygen should be administered to supplement the need created by the diminished area of aëration; dry cups applied over the pleura are valuable to relieve pain. The pulmonary infarct tends to heal rapidly, and needs no other treatment than the avoidance of infection by the respiratory channel; to this end care should be taken to avoid raising any dust in the room, and on windy days to prevent its entrance from the outside. As a rule, general improvement takes place, and the patient passes in a few days or weeks to complete recovery, but it is always possible that death may close the distressing scene.

INTESTINAL FISTULA.—A fecal fistula is one of the commonest sequelæ to an operation for appendicitis, especially when the disease has advanced to suppuration or gangrene. FOWLER observed 6 cases in 169 operations on appendicitis (*Ann. Surg.*, May 18, 1894); VAN LENNEP gives 6 in 118 operations. M. F. PORTER noted 8 instances of fistula persisting for four months or longer after incision and drainage, out of 187 operations (*Amer. Jour. Med. Sci.*, Dec., 1893). E. MÜHSAM (*Mitt. a. d. Grenzgeb. der Med. u. Chir.*, 1903, vol. 11, 284) notes 78 cases of fistula occurring in Sonnenburg's practice in a series of 441 operations for appendicitis, while in a further study of 815 cases, immediately following those just cited, there were only 54 fistulas, showing a difference of 6.6 per cent. in contrast to 16.3; an improvement of almost 10 per cent., attributable in part to increasing experience and greater skill of the surgeon, and in part to better judgment among physicians, who recognize the appendicitis earlier than formerly and send their patients more promptly for operation. It should be noted that three of these fistulas, one of which was vesical, were not post-operative.

The fistulas which originate spontaneously through the discharge of an abscess onto the skin surface have been already discussed (Chap. XVII) and I desire to speak here only of those which occur as sequelæ to operation. Fistulas of this kind vary from those which are extremely minute, secreting not more than a drop or two *per diem* of a purulent and watery fluid, to those with a freer secretion of thin fecal matter and bubbling gases; or, it may be, the entire alvine evacuation, short-circuiting the cæcum, escapes by this route.

The external opening of the orifice may be single or multiple; or, occasionally, it may be cribriform. After traversing the abdominal wall the fistula may open into the appendix directly, or into the colon at the base of the appendix, or into the colon or cæcum at some point above the base, or, in rare instances, into the ileum. Blind fistulas are rarely seen. SONNENBURG mentions a fistula (not post-operative) in which a communication had formed between the cæcum and a pocket containing fecal concretions. In this case the appendix had sloughed off and left a perforation opening into the bowel at the base of the appendix, while the surrounding reactive peritonitis had been able to build up a wall of adhesions dense enough to shut off the peritoneal cavity, as well as any other route by which the infectious material might be discharged. Such blind fistulas are occasionally met with as a disagreeable surprise in interval operations.

Our surgeons ought to distinguish carefully between a fistula and a slow-healing sinus in which there is no communication with the bowel at the base. A sinus is nothing but a pocket, kept from healing by some foreign body, as a ligature or a concretion, or by the devitalized tissues of its walls, while a fistula must be a through-and-through communication between the intestinal tract and the surface of the body. I do not speak here of fistulas between the adherent vermiform appendix and the adjacent cæcum or the ileum, nor of fistulas opening into the vagina or the bladder.

Etiology.—A fistula rarely follows an ideal operation in which the amputation of the appendix has been made in sound tissues and followed by a satisfactory suturing of the opening. The causes of fistula are most commonly to be found in the conditions imposed upon the operator by the nature of the disease; for example, they occur oftenest when it has been possible only to incise an abscess, leaving behind, from necessity, the perforated, sloughing, or gangrenous appendix. The simplest forms of fistula, in which there is no fecal discharge, are apt to occur when the perforation takes place either at the tip of the appendix or somewhere in its course beyond the base. A fistulous tract is sometimes kept open by a foreign body, such as a fecal concretion which has escaped from the appendix and lies in the iliac fossa, or by a silk ligature hurriedly applied to the base of the appendix in an abscess case. In a case of PORTER'S (*Amer. Jour. Obstet.*, 1902, p. 688) an abscess had been incised and drained, leaving a sinus, and whenever it closed, the patient, a little boy, had a fresh attack of pain only relieved by its spontaneous reopening. On opening the abdomen a large fecal concretion was found in an appendix entirely detached from the bowel. In several of SONNENBURG'S cases the fistula was due to tubercular disease of the appendix; in two out of five there was a lung affection as well. This possibility should always be borne in mind when a fistula, secreting a thin fluid, remains persistently open without apparent cause. A careful physical examination of the chest, as well as of the secretions of the fistula, may illuminate the diagnosis.

A fistula is particularly apt to follow an excision of one of those old inflamed appendices found lying behind or to the outside of the cæcum,

and so densely adherent that any attempt to dig the organ out of its bed is almost sure to be accompanied by the rupture of the outer coats of the bowel; such an occurrence, possibly not recognized at the time, may be followed by the sloughing of the remaining thin septum, and the escape of the contents of the bowel. It is evident that the occurrence of such an untoward sequela, interrupting recovery and retarding convalescence, is always due to imperfect technic; that is to say, to a technic which while it may have been necessarily imperfect under the conditions imposed upon the surgeon, would yet have been better, perhaps even ideal, had the patient been seen before the existence of the complications. In a bad case, however, where the operation is done upon an *indicatio vitalis*, the surgeon may be well content if he saves life, whatever disagreeable concomitants go with the purchase.

Treatment.—Prophylaxis is perhaps the most important element in the treatment of fistula, because so much can be done to avoid a result so annoying to the surgeon, and a source of great mental disquietude to the patient. *Pari passu* as appendicitis is recognized and operated upon in the earliest stages of the disease, that is to say, before the formation of an abscess, is fistula unlikely to occur. As long as abscess cases, especially neglected ones, continue to be incised and drained, just so long will fistulas continue to soil the dressings. KOCHER's plan of making a separate incision a few days after opening and draining the abscess in order to discover and remove the appendix, will lessen the frequency of fistulas in the suppurating cases. A fistula will never arise in a simple case if fine silk sutures are used for the bowel, while catgut is employed only in tying off the mesentery. When the appendix is simply ligated and amputated in an abscess, formalin or chromicized catgut ought to be used. Surgeons will reduce their percentage of fistulas if they take great care to excise well into the sound tissues, and then sew up the bowel opening with mattress sutures, using fine silk and a fine needle and burying the wound under one or two layers of sero-serous sutures. I have never seen the fine silk sutures give rise to any after-disturbance.

A serious form of fistula, namely, that arising from the rupture of the outer coat of the cæcum or ascending colon in the enucleation of a densely adherent appendix, will be avoided by following the plan of first detaching the appendix from the bowel at its base, then incising the peritoneal and longitudinal muscular coat along its dorsum, and finally stripping the appendix out of its bed inside its circular coat and with its mucosa, leaving the bowel untouched (see Chap. XVII). If this is done, a fistula will rarely ever be seen after an interval operation.

In the case of a post-operative fistula of doubtful etiology it is well to explore it with a little crochet hook, and if there is a ligature at the bottom to draw it out. It is well also to keep all abscess cavities widely open, and wash them out vigorously so as to remove any foreign body. Where the cæcal wall about the base of the appendix seems likely to break down, it is a good plan to draw the omentum down over the affected area and suture it there at the base of the appendix (SONNENBURG).

MÜHSAM (*Mitt. a. d. Grenzgeb. der Med. u. Chir.*, 1900, vol. 5, p. 111) conveniently divides fistulas, from a clinical stand-point, into those in which the discharges are purulent and those in which there is leakage of fecal matter. Out of 441 case of appendicitis in the Moabit Hospital and in the private practice of SONNENBURG and HERMES, fistula occurred 77 times. Of 25 operative cases in which the discharge was purulent or serous, closure of the fistula occurred in all but three; secondary operations were done in 10 instances. There were no deaths. Out of 49 operative cases having fecal discharge 30, or about 62 per cent., had complete closure of the fistula. Seven were improved as a result of operation but were left with a small fistula and 12 died. There were 3 cases of spontaneous fistula among the 77. The causes of death in the 12 fatal cases were: three times, tuberculosis; once (probably), post-operative hemorrhage; six times, peritonitis, recognized in part at the time of the operation; once, ileus; once, progressive weakness.

Fistula (even in aggravated cases) tends to spontaneous recovery in such a remarkable way, even, it may be, after weeks and months, that the expectant plan of treatment should always be the first thought of the surgeon. G. W. PERKINS had a case where for two weeks all the fæces were discharged by the wound, but in the fourth month a complete recovery had taken place. T. W. HARVEY, of Orange, N. J., had a curious case in which a fistula closed after a few days, and then opened again to give exit to a large round-worm, after which it closed definitely. On the other hand, a case of GAGE's ran seven years and then recovered.

After an operation in which there is reason to anticipate a fistula, it is best to avoid a tight packing in suturing the wound. It is, further, a matter of urgent importance to avoid interfering with the delicate granulations which form and tend so rapidly to blockade any preternatural openings; by such means alone can nature cure the ill; if these are repeatedly broken down through a meddlesome and mistaken zeal, a fistula may even be created where none would otherwise have occurred. The first complete change of the dressings may take place after five days or a week, as in other abdominal suppurative conditions; the outer layers of gauze which soak up the secretions on the skin surface being removed constantly in the mean time.

The patient in danger of acquiring a fistula ought to receive only a minimum amount of food, and live as much as possible on albumin water. The bowels, if quiet, should be opened by a rectal enema consisting of a few ounces of oil, after five or six days. As long as the fistula is discharging, the wound should be kept widely open, more widely at the top than at the bottom, and the surface frequently cleansed by the attendant applying fresh gauze in the form of loose fluffy napkins. The surrounding skin should be protected from the irritating discharges by first carefully drying and then anointing freely with a stiff paste of oxide of zinc or an ointment of salicylate of zinc.

In bad cases of fistula, h y d r o p a t h y affords a treatment of the utmost value during the early stages of granulation. By this method the wound is kept continually bathed by the circumambient water and thus kept clean; the closure goes on with surprising rapidity, and greatly to the satisfaction of the patient. If the patient can stand it, he does best kept in this bath for the entire day, with shoulders and chest well wrapped and protected; a weaker patient may remain one to two hours at a time, each morning and evening. After removal from the bath, a vigorous rub, a warming drink, and a comfortable bed induce an enviable state of *bien-être*. In my private hospital I have such a bath arrangement installed in a room adjacent to a bath-room, where the supply and discharge pipes for attachment to the tub when needed are conducted along the wall under the skirting-board; in the bath-room there is a large gas heater with a thermostat which acts upon the coils of water pipes by which the water is discharged at a constant temperature of, say, 102° F. in a slow stream into the bath-tub, if possible directly over the wound; the outflow going on, of course, at the same rate. By this means a continuous temperature is easily maintained and the wound has the advantage of a constantly changing water dressing, while the patient has the comfortable assurance of perfect cleanliness.

The closure of a fistula by operation may vary all the way from a procedure which is comparatively easy (in skilful hands) to one of the utmost difficulty. If there is more than one opening on the skin surface, it is best to do a preliminary operation by slitting up the skin so as to establish a single orifice which leads directly to the fistulous tract, in this way getting rid of the undermined infected area. Such cases which seem most difficult at first sight may prove comparatively easy in the end. If the skin is much excoriated an effort should be made to heal it by protecting it with a stiff bland salve and keeping it clean. The bowels should be well evacuated and the stomach emptied before the operation. If the fistula leads directly down to an appendix which is only slightly adherent, the operation presents but little more difficulty and danger than the ordinary interval operation. HALSTED deals with the fistulous orifice by surrounding it with a purse-string suture, which is then tied, closing the opening; the suture is left long enough to serve as a tractor, making tense the sinus, and so marking it out, while the operator carries his dissection inward toward the objective point, the intestinal opening. Another plan is to stuff into the sinus a narrow strip of iodoform gauze which serves to plug the opening, the operator then depending upon the rigid canal as his guide.

In a s i m p l e fistula the operator may excise the adjacent abdominal scar tissue, including the fistulous orifice, and so carry the dissection inward to the bowel; at the same time it is kept as close to the fistulous tract as possible until the bowel is reached. The intestinal end of the fistula is then excised in the sound tissues of the bowel, and sewed up with fine silk mattress sutures taking in all layers down to the mucosa, a continuous sero-serous suture being applied above these for security.

The parietal wound is then closed, down to an opening the size of a little finger, which is left with a small drain for a few days for security.

In difficult cases, if the fistulous tract is a long one walled in by adherent intestines and cæcum, it is not safe to try the simple plan of excision, for there is great risk of injuring the adjacent bowel by working in the dark. Under these circumstances it is best to carry the skin incision completely around the old scar, including the fistulous orifice, and to enter the abdominal cavity at a distance above and below the fistulous area. This gives a chance to study carefully the extent of the involvement of the adjacent intestines, which can then be dissected free, together with the omentum; after this the fistulous area is gradually isolated from end to end by working backward with a blunt dissection needle. The bowel is then lifted out onto the skin surface, the fistula is excised, and the opening closed by suture.

The extent of a difficult operation for post-operative fistula will be realized by consulting the description given by W. W. KEEN in the *Medical News*, December 10, 1892.

An unusual instance of a permanent fecal fistula of the small intestine following the opening of an abscess, which was treated with great surgical skill, is that of G. W. PERKINS, of Ogden, Utah (*Ann. Surg.*, 1896, vol. 24, p. 726). ("The Vermiform Appendix and its Diseases," p. 679.)

SONNENBURG, in a case of fistula of the small intestine in the neighborhood of the cæcum, attempted to relieve the difficulty by resecting the affected part of the ileum and joining the ends by means of a Murphy button. The patient, however, unfortunately died from the progressive peritonitis which had begun at the time of the operation. The fistula in this case was noticed three days after the operation, when fecal matter was found in the dressings; three days later the patient died.

When, owing to the density of the adhesions, the extensive cicatrices, or the immobility of the bowel, fistulas cannot be closed, several plans of treatment come up for consideration. The whole mass may be resected, as in cancer, actinomycosis, or ileocæcal tuberculosis, and the sound end of the ileum above the disease joined to the sound end of the ascending colon beyond the disease. In cases in which the disease cannot be extirpated, the ileum may be anastomosed into the ascending or transverse colon, and this may be done as a simple anastomosis, or the entire diseased area may be excluded from the continuity of the intestinal area by amputation and closure by suture of both ileum and colon. The "ventilated opening" which V. BARACZ has shown to be necessary for the excluded bowel (*Archiv f. klin. Chir.*, vol. 58) may be provided by the fistula.

VON EISELSBERG (*Archiv f. klin. Chir.*, 1898, vol. 56, p. 22), under the title "*Ueber die Behandlung von Kotfisteln und Stricturen des Darmkanales mittelst der totalen Darmausschaltung*," reports a case where the incision of a perityphlitic abscess resulted in the formation of an *anus preternaturalis cæcalis*. A coeliotomy was done to heal this condition, but on account of the extensive adhesions of the cæcum, as well as of the coils of the small

intestine themselves, neither resection nor total exclusion of the bowel could be done; total exclusion was impossible, as the operator could not determine which was the distal end and which the proximal end of the ileum. Under these circumstances he did a lateral ileocolostomy. By this means the *anus preternaturalis* was converted into a fecal fistula. Inasmuch as this continued to discharge freely, a second operation was performed seven weeks after the first, when the diseased portion of the bowel was divided from the remaining sound tissue, and the ends sewed up sausage fashion, four lumina, two cæcal and two iliac, being closed in this way. This operation was followed by a perfect recovery. The whole illness lasted about eight months. In a favorable case an end-to-end anastomosis of the ileum into the ascending colon might be done.

URINARY FISTULA.—A urinary fistula is, fortunately, of rare occurrence after an operation for appendicitis. A case of this kind, which was, in all probability, a wound of the ureter, is reported by C. A. POWERS (*Med. News*, 1899, vol. 75, p. 247).

MÜHSAM reports the case of a vesical fistula in a man twenty-eight years old, who in the course of a third relapse in appendicitis acquired a perforation into the bladder. This was followed by the discharge of large amounts of pus in the urine which also contained gas and had a foul odor. The appendix was released from its adhesions and removed with the utmost difficulty, but the point of perforation could not be found; cystitis continued, but after two months the patient appeared to be well again, until, later on, the urine became turbid again and contained plant cells and undigested fibres, and showed a connection between the cæcum, which had been shelled out close to the bladder, and the bladder itself. About a year after the first operation a median incision was made, when the last loop of the ileum ascending to the cæcum was found intimately adherent to the bladder by adhesions which could not be separated without great danger to both bowel and bladder. An anastomosis was then made between the ileum and the upper part of the cæcum, in the hope of diverting the fecal current from the fistula. The patient improved remarkably, the urine became clearer, and he seemed to be quite well except for the fact that the Murphy button, used in making the anastomosis, failed to pass out. The X-ray showed the button lying over the right sacro-iliac synchondrosis, where, however, it seemed to create no disturbance.

SKIN AFFECTIONS.—I have found but one instance in literature in which appendicitis was followed by *dermatitis*.

ACUTE YELLOW ATROPHY OF THE LIVER.—A case of this condition occurring as a sequel to the removal of the appendix under chloroform anæsthesia is reported by M. BALLIN (*Ann. Surg.*, 1903, vol. 37, p. 362). The patient, who was a brassworker, twenty years old, had three typical attacks of appendicitis and was operated upon during the third, when the appendix was found adherent, friable, and covered with fibrinopurulent exudate. It was removed and the stump touched with carbolic acid, but it was impossible to cover the stump, as the thread cut through the

infiltrated tissue. The abdomen was closed without drainage, the whole operation being under ether narcosis. Two days later, when the temperature and pulse were normal, slight jaundice of the skin and conjunctiva were observed. At the end of another two days the jaundice increased, being accompanied by greenish vomiting and delirium. The next day the jaundice was still worse, the delirium became noisy, with intervals of coma, and the vomited matter was black. These symptoms increased, the stools and urine became involuntary, and the delirium extremely violent. The jaundice deepened to a dark brown color, when venesection and intravenous infusions were tried, after which there was a gradual improvement and finally complete recovery. Six days after operation the urine contained albumen, casts, bile, and crystals of leucin and tyrosin.

Another instance of liver degeneration, found at autopsy following the removal of a gangrenous appendix in a boy of twelve, has been reported by P. HEBERT and R. DUPONT from Broca's service (*Rev. des mal. de l'enfance*, 1906, p. 413). In this case there was a gangrenous appendicitis in an abscess behind the cæcum in the right flank. The abscess did not extend as high as the liver. The patient died at the end of thirty hours, and at the autopsy the liver was found completely degenerated.

BAYARD HOLMES reports two similar cases of acute yellow atrophy of the liver occurring in young women ("*Four Clinical Notes on Appendicitis*," Chicago, 1904, p. 17), in which the symptoms preceding death were, he says, "comparable only to acute yellow atrophy."

INTESTINAL OBSTRUCTION.—An ileus is an obstruction of some portion of the lower alimentary tract interfering with the passage of the intestinal contents. The term *ileus*, now commonly used by surgeons to denote an anatomic condition, more properly refers to the severe twisting, colicky pain which is the characteristic sign of the affection.

Etiology.—The obstruction which produces an ileus may arise from a number of causes, such as a volvulus or twisting of the bowel, following an injury; adhesions between loops of bowel and strictures within the lower abdomen; the slipping of a loop of bowel underneath a peritoneal band, resulting from an old peritonitis; the incarceration of a loop of bowel under other adherent loops, or under an adherent omentum, or an attached or twisted appendix. Intestinal obstruction occurring as a complication of appendicitis is oftenest due to sharp flexures caused by the numerous adhesions at the terminal portions of the ileum, arising in the course of nature's efforts to shut off an infected area. When it follows an operation for appendicitis, at a date more or less remote, it is apt to arise from the constriction of bands of adhesions cutting across the small intestine.

Among all the various causes of intestinal obstruction, one of the most important is paralysis of the bowel from a gaseous distention. This distention may be so marked and the symptoms

of obstruction associated with it so pronounced that the original disease in the appendix is entirely masked. The obstruction may be immediate and complete; as a rule, however, it comes on gradually, only becoming complete after a few hours, or, it may be, several days. Where the obstruction is only partial, the signs of it may be intermittent in character, occurring only when the upper bowel becomes overloaded. The result of an obstruction is the accumulation of fluids and gases in the upper proximal portion of the bowel, while the lower distal portion is empty and contracted. It is of the utmost importance to bear this fact in mind when endeavoring to locate the obstruction, in order to avoid hunting aimlessly among the bowels under circumstances when time is too precious a commodity to be wasted.

KADER, following v. WAHL (*Centralbl. f. Chir.*, 1891, No. 26, p. 106), states that meteorism is due to an increased circumference of the intestine occasioned by the following factors.

1. Increased thickness of the intestinal walls.
2. Accumulation of fluid within the bowel.
3. Development of gases within the affected loops.

And, as the result of experiments on dogs, he declares that meteorism in all forms of intestinal occlusion is a consequence of two complementary factors, which are (1) circulatory disturbances in the venous system; and (2) stagnation and decomposition of the contents of the bowel.

Obstruction of the intestines following operation on the vermiform appendix is almost invariably situated in the neighborhood of the ileocæcal valve, that is to say, in the last group of the small intestines located in the right lower abdomen. In searching for the obstruction, therefore, we are able to neglect the proximal groups of the ileum and jejunum, and devote attention at once to the omentum and the last group which occupies the pelvis and the right iliac fossa. I would especially call attention to the fact that the terminal portion of the bowel in this group is usually found lying on the pelvic floor, from which it ascends to terminate at the ileocæcal valve, its mesentery growing shorter and shorter until at the valve it almost disappears.

A. T. CABOT, in speaking of chronic obstructions of the bowel with recurring symptoms, draws attention to the partial twists and kinks found when the terminal ileum lies over the head of the cæcum, and walls in an inflamed appendix to the left and in front. If the bowels are in good order, they are able to pass their contents comfortably through such a partially obstructed coil; when, however, they are overloaded, peristalsis is checked and all the symptoms of an acute stoppage ensue.

It is of the utmost importance to recognize the fact that an intestinal obstruction is not due simply to the existence *per se* of adhesions between the various coils of intestines, however numerous these may be. The entire intestinal tract may be bound together by webs of adhesions or the whole peritoneum may actually disappear, without producing an obstruction. An obstruction arises when a loop of bowel is caught and held in

a lower position than that which it naturally occupies in the abdomen, as, for example, when one of the loops normally lying well above the pelvis grows fast to a pelvic wound. If a small area of the bowel is held fast in this way, a sharp kink occurs and a knuckle adhesion, which is much like a finger flexed sharply upon itself, is formed. Another way in which an obstruction occurs is by the formation of adhesions between two loops of bowel, which then contract and bind the intestine in one fixed position. Again, after adhesions have formed between two different loops of intestine, another loop may slip in underneath the adhesion, as under a bridge.

One of the commonest causes of late post-operative obstructions is the gradual rolling up of a thin layer of adhesions into a strong band by the contractions and tuggings of the intestines. All band adhesions are formed in this way. The more recent the adhesion (if it is not omental), the more apt it is to involve broad surfaces, and on this account the difficulties in dealing with it are increased.

Symptoms.—The cardinal symptoms of intestinal obstruction are: Obstipation; intermittent abdominal pain; vomiting, becoming fecal in character; gaseous distention, often localized. The vomiting is at first bilious and from the upper intestinal tract, then ill-smelling, and finally, fecal; colicky pain coming on at the same time and usually beginning at one spot in the right lower abdomen, after which it becomes general and is associated with vermicular contractions of the bowel, easily felt, and often visible. These symptoms are accompanied by gurgling sounds due to the movements of flatus in the coils of intestine. A marked localized tympany soon develops and the passage of flatus and feces *per anum* ceases entirely. The temperature is slightly if at all affected, and the pulse is at first quickened only during the tormina. In the post-operative form of ileus the development of these symptoms is often gradual, and the first indication is an increasing difficulty in moving the bowels.

Diagnosis.—A diagnosis of obstruction is easily made in the presence of the symptoms just mentioned. One of the most characteristic signs is the formation of a hard tumor, due to the contractions of the intestine just above the obstruction, and easily detected by laying the hand upon the abdomen. The vermicular movements of the bowel and the displacement of the gases as they rumble from loop to loop are also often easily felt. The leucocyte count is of little value, because it may show a marked rise early and then a drop.

Treatment.—The amount of progress made in the treatment of obstruction during the short space of sixteen years is evident on the perusal of such an article as ROSWELL PARK's brief but lucid paper entitled "*Laparotomy or Enterostomy*" (*N. Y. Med. Rec.*, March 3, 1888). It is hard to realize that shortly before this date the treatment of ileus belonged exclusively to the domain of internal medicine. The emancipation heralded by PARK and his contemporaries began with the introduction of surgical

measures in the opening of the obstructed bowel onto the skin surface; and then advanced to the making of larger incisions, in order to inspect the affected area, and if possible relieve the cause without doing an enterostomy. KÜMMELL as early as 1887 advocated an exploratory incision extending from sternum to symphysis (*Centrbl. f. Chir.*, 1887, No. 45, p. 836). SCHEDE (*Arch. f. klin. Chir.*, No. 36, p. 635) insisted that "the fate of those suffering from an ileus depends entirely upon an early diagnosis. There is, perhaps, no other acute disease in which the patient's ability for resisting shock so rapidly vanishes."

The best treatment of intestinal obstruction, as of other post-operative complications, is by prevention, effected by taking care during the operation to remove, as far as possible, all existing difficulties and to avoid causing any injury which is liable to result in obstruction. This is accomplished by a minimum exposure and handling of the intestines; by keeping exposed peritoneal surfaces moist with a warm saline solution; by hunting out and relieving all adhesions which can possibly be found; by covering in any raw or bleeding surfaces with intact peritoneum, and by draining septic areas in such a manner as to prevent the extension of the infection. If the bowel is badly injured and requires extensive suturing, especially in operations which must, of necessity, be done in haste, the dangers of a fatal peritonitis, or of an ileus, may sometimes be obviated by bringing the injured loops of intestine into the wound and leaving them exposed there. Should this part of the bowel break down later, the discharge takes place onto the surface and no harm is done, as the resulting fistula may be closed at a later date. It is best to avoid the use of long strips of gauze for the purpose of draining between the intestines, as a slight displacement of the coils of the bowel serves to produce a kink or an obstruction.

When an obstruction occurs after a gauze pack has been introduced into the wound, the first thought of the surgeon should always be that the stoppage is due to the pressure of the gauze, or to the entanglement of a loop of the intestine by strips of it. The first effort to relieve the cause should be to remove the pack, and perhaps readjust or straighten out any coil of intestine which is obviously kinked. Every surgeon of experience has had occasion, more than once, to relieve cases in this way which at first sight seemed alarming. It is a good rule to give an anæsthetic and do this little operation thoroughly, as it may obviate the necessity for a far more serious operation later on. A bad case can also sometimes be relieved by opening the distended bowel in the wound with the cautery point, thus establishing a fistula. Cases which have seemed almost moribund from obstruction and gaseous distention have been repeatedly saved by making an artificial vent in this manner.

In cases in which the bowels are becoming more and more difficult to move, or in those where an obstruction has certainly developed though the vomiting and pain are not yet pronounced, if the patient's condition is good, the surgeon may try for a short time to effect a movement by giving enemata, such as a pint of water containing a tablespoonful of glycerin

and two teaspoonfuls of turpentine well shaken together, or glycerin and oil. A useful enema is made by dissolving an ounce of Epsom salts and one ounce of glycerin in eight ounces of hot water. The administration of calomel, or even castor oil, by the mouth may be tried. It is best not to give any nourishment at all. The passage of gas is encouraging, as it is often the premonitory sign of a fecal movement, but if this does not shortly occur, especially if the symptoms continue unabated or begin to grow worse, it is better to interfere promptly, rather than continue to make efforts to force a passage and so exhausting the patient's strength. In few diseased conditions is time so important; a patient who appears to have been doing well while purgatives are being poured into him and the physician is anxiously watching at his bedside, will often show signs of collapse, and within an hour or two it becomes evident that a more radical plan of treatment has been delayed too long. It is better to make a few mistakes, and to open the abdomen occasionally without necessity, than to delay systematically in all cases and then, when operation is performed as a last resort, to lose every case operated upon.

I would therefore advise operating promptly as soon as the patient fails to respond, provided the classical signs of obstruction are present.

When there is fecal vomiting the stomach should be thoroughly washed out before operation. If this cannot be accomplished, it is better to do the operation under cocaine than to risk drowning the patient in his own vomit as he goes under the anæsthetic. Where time is so important, all preparations should have been made beforehand. The abdomen must be cleansed while the anæsthetic is being given, and the operator should stand ready to begin the operation the moment the patient is ready. It is best to give the anæsthetic on the operating table. The cardinal rules of operation in ileus are as follows:

1. The operation must be done as promptly as possible when the diagnosis is once clearly made.

2. It must be as brief as consistent with thorough work.

3. As little anæsthetic as possible should be given, but the relaxation must nevertheless be complete. Local anæsthesia (Schleich's solution) is best in bad cases where there has been much fecal vomiting (see Chap. XVI).

4. The bowels should be handled as little as possible.

5. It is especially important to avoid pulling upon the bowels.

6. Evisceration should be avoided as far as possible, the proximal distended coils in the abdominal cavity being left *in situ*, and the search directed beyond them (distally), near the ileocæcal valve, for the obstruction.

7. It is better to empty any escaping over-distended bowels than use force to replace them.

8. If the obstruction is not partially overcome, as shown by the distended bowel beginning to unload itself at once into the lower intestine, a distended loop must be brought up into the wound and left there to be opened a little later.

9. If there is any doubt as to the complete relief of the obstruction, a loop of bowel must be brought up into the wound in readiness for enterostomy.

10. The use of saline infusions with a little adrenalin (15 to 20 cc. of 1:1000 solution of adrenalin in 800 to 1000 cc. of normal salt solution) is of value in keeping up the heart action.

11. Every possible effort must be made to keep up the body-temperature and to avoid chilling the patient from exposure of the viscera.

The operator who opens the abdomen to relieve an ileus must in each case do one of three things: he may (a) overcome the obstruction by dividing adhesions or loosening attached coils of intestine; if unable to overcome the obstruction, he may (b) short-circuit the bowel across the obstructed area by an anastomosis of the ileum into the colon; or he may (c) bring a loop of the bowel above the obstruction onto the surface for an enterostomy later on. If the last method is used, it is well to mark the point for incision by inserting black silk threads in the outer coats of the bowel and leaving them hanging out of the wound. When the operator is uncertain as to whether he has completely overcome the obstruction, he can employ a combination of these methods by leaving the wound open and bringing a loop of bowel into it, ready to be incised if the symptoms persist.

Where the original operation has been a comparatively simple one, the operator may expect to find nothing more than the simple adhesion of a knuckle of intestine, or the free border of the omentum, under which the ileum has slipped to the head of the cæcum, the latter forming a large gurgling tumor yielding signs of an incomplete obstruction. I saw such a case in consultation with B. C. HIRST, in which the patient suffered severe paroxysms of pain at variable and sometimes considerable intervals, associated with swelling to the right of the umbilicus and an extremely tender abdomen. The obstruction, however, was manifestly partial, as there was no fecal vomiting, and the passage of the intestinal contents was obviously only impeded. At the operation the edge of the omentum was found adherent in such a manner as to form a strong band attached at the seat of the appendix operation. A large, deeply reddened loop of ileum had slipped under this band and then dropped down in front of the omentum so as to form an incomplete strangulation. Fig. 177 shows the condition as found at the operation. In such a case the old incision may be cautiously reopened, after which the bowel is released by freeing and suturing the loop or by dividing the omentum. In the case of a relative of mine, a boy of fourteen, I made a little opening parallel to and inside of the first incision, after which I freed a single knuckle of the ileum and evacuated a serous accumulation. Recovery followed.

If a loop of bowel is evidently gangrenous and in need of resection, while at the same time the patient's condition will not permit any extension of the operation, the difficulty may be met and life in many instances saved by the simple expedient of bringing out the gangrenous loop onto the surface of the body, together with a sufficient amount of the adjacent,

apparently healthy bowel to provide for a possible extension of the gangrene. The diseased bowel is opened and left, carefully wrapped in dressings, isolated from the wound. At a later date, when the sloughing process is completed, the ends of the bowel may be anastomosed without using a general anæsthetic.



FIG. 177.—HIRST'S CASE. INTESTINAL OBSTRUCTION FOLLOWING OPERATION FOR APPENDICITIS DUE TO OMENTAL ADHESION OVER STUMP OF THE APPENDIX. JANUARY 18, 1903.

Points to be noted when Operating for Intestinal Obstruction following a Primary Complicated Operation.—When there has been an abscess, or when the adhesions have been extensive at the original operation, it is best to open the abdomen by a long incision medianwards from the original one, and not more than one or two inches distant from it. The viscera must first

be carefully inspected, in order to determine whether the obstruction is situated at a particular point or is caused by general adhesions. The distended portion of the intestine must next be noted, as well as the presence of any collapsed bowel on the proximal side of the ileocæcal valve, which, if present, must be traced up to the limit between the two, after which the operator may proceed to deal with the disease according to the findings, which are likely to be one of the following conditions.

1. A band or bands of lymph stretching over the pelvis and the intestines.

2. A twist in the bowel, or, in other words, a volvulus.

3. Omental adhesions with a loop of bowel caught under the free edge.

4. A loop of bowel, or several loops, adherent at the site of the operation, at the abdominal incision, to an abscess wall, or, it may be, in the pelvic cavity.

5. Angulation of the ileum, produced by the adhesions binding together distant loops.

6. Angulation of the ileum over the cæcum.

7. General adhesions among the bowels in which a particular line of demarcation defining the obstructed area is scarcely discoverable.

Great care must be taken not to overlook bands of adhesions, especially if they are a little distance from the field of operation, when it is very easy to do so. I had a case of this kind recently, in which an obstruction followed an operation for appendicitis, and the bowels were so matted together that a fecal fistula had been formed to give relief. I opened the abdomen widely in the old scar, dissected out and sewed up two fistulas, one in the cæcum and one under the ileum, and then found the obstruction lying at the splenic flexure of the colon. The proximal portion of the large bowel was so enormously distended that it resembled a large stomach, and appeared to fill the abdomen. After dividing numerous adhesions around the head of the cæcum and under a long scar in the median line, I found some strong bands of adhesions passing from the pelvis upward in the direction of the obstruction. These I caught under my fingers, and divided them with scissors, being guided in doing so by touch alone, on account of the distance from the wound. The tumors which had been formed by the colic mass disappeared when the patient recovered. Later a tumor was found at the splenic flexure, necessitating an anastomosis of the ileum into the descending colon.

When a mass of adhesions is to be dealt with, it is best to handle it as a whole, first locating the sound areas above and below, and then, if possible, bringing the mass outside and surrounding it on all sides with wet saline gauze. The loops, which stretch like bridges across other loops, are best detached by pulling them apart with pledgets of wet gauze, a light being held at the same time on the other side. In this way, as the adhesions are pulled apart a little at a time, it is possible to cut between the loops without injuring the coats of the bowel or of the blood-vessels. This method of inspecting adhesions so as to differentiate between them and

the viscera, and at the same time discover the presence of blood-vessels, I have called *diaphanoscopy*, in order to emphasize it as a practical procedure. It is well not to refine too much in dividing all the adhesions between areas of the bowel which are naturally separated by only a few centimetres.

The worst cases of adhesions are those on the pelvic floor. The treatment of these requires abundant room and light, and can only be accomplished after displacing the other bowels. After isolating the affected loops of bowel in the manner just described, it is best, if circumstances will permit, to elevate the pelvis, and then, while making a little gentle traction upon the bowel, to snip the adhesions very slowly and deliberately with scissors. If the coats of the bowels are injured, one or two fine mattress sutures must be put in at once. In a case where the general adhesions are badly matted, it is best to be satisfied with bringing out a distended loop of the intestine to be incised soon after the operation; a few weeks later the fistula may be closed.

When the adhesions are too extensive to be dealt with, or when there is imminent risk of rupturing the intestines in separating them, a lateral anastomosis of the distended ileum into the cæcum may be made.

COLEY reports a case (*Ann. Surg.*, 1900, vol. 22, p. 451) of a boy operated upon in April, 1896, for an acute appendicitis from which he made an uneventful recovery. In August of the same year he developed symptoms of acute intestinal obstruction, and on opening the abdomen three and a half feet of intestine were found strangulated, which it was necessary to resect. The procedure was followed by a fistula, the boy's general health failed, and he became greatly emaciated. At a second operation, in November, 1899, an incision 2 inches long was made to the left of the sinus, the adhesions were separated, and the ends of the gut resected, after which they were approximated with a Murphy button. The wound was drained for a week. The boy's health improved rapidly and he gained 23 pounds in six weeks.

HERNIA.—Hernia following an operation for appendicitis is due to a separation of the firm aponeurotic and muscular structures which constitute the natural support of the abdominal viscera. Such a diastasis is followed by an eversion of the thinned out cicatricial tissue so as to form an extra-peritoneal diverticulum or pouch which is occupied by the omentum or the intestines. A hernia of this kind may occur at one or several places in the tract of the wound, and generally makes its appearance after an interval of a few months to one or two years after the operation.

Etymology.—As regards the frequency of hernia following operations upon the appendix: HOMER GAGE found 19 hernias in 228 cases operated upon for appendicitis, the subsequent history of which he investigated. This is 8 per cent. and all made their appearance in cases which had been drained; 17 appeared in the first, and 2 in the second year after operation. The greater number occurred during the first six months.

Post-operative hernias are more apt to occur where the tissues have lost their tone or in flabby neurasthenic patients. There is, of course, a

greater liability to hernia when a long abdominal incision has been made, but the prevailing impression that a tiny incision, from an inch and a half to two inches in length, is a guarantee against the occurrence of hernia is not borne out by the facts. I have myself seen a case in which a minute incision about 5 cm. long at the outer border of the rectus muscle suppurated, and a year later, when I operated upon the patient, a well-built muscular young man, there was an omental hernia at this point. One of the most serious objections to long incisions, especially when made parallel to the border of the rectus muscle, is the fact that it is still the common practice to divide the tissues without any effort to save the nerve trunks which supply the rectus. When these nerves are thus ruthlessly cut, an atrophy of the muscle follows, and even if a hernia does not take place, there may be a distinct weakness and bulging of the abdominal wall over the atrophied area. A careless closure of the abdominal wall, associated with neglect in bringing the layers together in their proper order or carelessness in placing the sutures at too great intervals, also predisposes to hernia, which is more apt to occur in patients who are slender at the time of the operation, but grow stout soon afterward and lead a life of active exertion. The commonest of all causes, however, is the necessity in abscess cases for leaving the wound open for drainage. A wound of this description closes slowly, and when it finally does so, the cicatrized margins are held together by a veil of scar tissue that yields readily to any pressure from within, such as is brought to bear upon it whenever the abdominal walls contract upon the contained viscera. If through some fault in technic, or some accidental contamination, a healthy wound is infected after closure, breaks down, and finally closes only after suppuration, the final result is the same as in cases which have been drained, and a hernia is likely to result.

Prophylaxis, which is the best safeguard against hernia, lies in the use of a small incision whenever it can be employed with equal safety, and in the separation of the muscular layers without cutting them (McBURNLEY, see Chap. XVII, p. 284). I cannot too earnestly advise against the unnecessary division of the important nerve trunks, the analogues of the intercostal nerve trunks above, which supply the abdominal muscles. It is one of the chief advantages of interval operations that it is never necessary to use drainage after them, and that the diseased appendix can be removed through so small an opening that liability to the formation of a hernia is minimized. In drainage cases something may be done to reduce the liability to hernia by establishing such free drainage for the first few days that the abscess quickly empties itself and begins to contract. The external wound may then be rapidly closed, and to this end provisional interrupted sutures of silver wire are laid during the operation as though the layers of wound were to be closed entirely and at once; they are then drawn aside and left loose until the drainage is almost completed, when the wound may be rapidly closed down to a small orifice which at last fills in with a plug of cicatricial tissue. When the abscess extends into the

pelvis, drainage by the vagina or by the rectum is preferable, both on account of its greater efficiency in a dependent position and the fact that any risk of hernia is obviated. Drainage cases should be kept in bed until the wound is firmly closed; the physician will then at least save himself the blame which is sure to be laid upon him if he hurries the patient out of bed and a hernia subsequently forms. Whenever there is any reason to fear the formation of a hernia, the patient should wear a snug-fitting bandage.

In spite of the utmost precautions a certain percentage of hernias are inevitable as long as surgeons are forced to operate in the suppurating stages of appendicitis. It must be remembered that in all such cases the operation is essentially a life-saving procedure, and the risk of a hernia must be accepted as a trivial consideration in comparison with the danger from which the patient is rescued. It is best to forewarn him in such a case, either just before or soon after the operation, and advise him to accept cheerfully an inconvenience which is so easily remedied by subsequent operation.

Treatment.—The proper treatment of a hernia is the excision of the scar together with the hernial sac, followed by the careful approximation of sound tissues in their natural order and relations, from the peritoneum to the skin surface.

It is important to remember that while the hernial orifice feels like a sharply defined ring as large as the end of the finger, that is to say, an inch or more in diameter, this ring is surrounded by thinned out areas of scar tissue, which often involve the entire length of the original wound, and are sometimes cribriform. In order to effect a radical cure of the rupture, this whole area must be dissected out. A ventral hernia can never be cured by simply exposing and suturing the sharp margins of the neck of the sac. Let me reiterate and emphasize the fact that the operation for hernia must include not only the actual, manifest, hernial sac with its orifice, but the entire weakened area in which the hernia is situated, and in which it is progressively extending its boundaries from month to month.

The operator proceeds by excising the scar and baring the tendinous muscular tissues, which are healthy and well vascularized; the various anatomic structures must then be sought out and recognized individually, after which they are laid bare so that they can be brought together broadly. As a suture material it is best to use fine silk or silver wire, at intervals of from 2 to 2.5 cm., so as to splint the tissues together in their proper order; catgut may be employed between these sutures to secure accurate approximation. After such an operation the patient should remain in bed not less than three weeks, and go about with caution for many weeks longer.

When the hernia is at the border of the right rectus muscle, its cure is more difficult, as the lateral oblique muscles must be united to the vertical rectus instead of being approximated to homonymous tissues, as in hernias situated more laterally. A. B. JOHNSON gives a clear description of the procedure to be pursued for hernia in the semilunar line (*Ann. Surg.*, 1899, vol. 29, p. 625). The patient, a woman, forty years of age, had been operated upon at the Roosevelt Hospital for an appendicitis with abscess,

and three years later she was re-admitted with a hernial protrusion measuring 3 by 4 inches, situated at the right border of the rectus muscle. After excision of the scar and of the peritoneal sac, the outer margin of the hernial ring, consisting of the aponeurosis of the external oblique and tendinous



FIG. 178.—SHOWING LARGE HERNIA FOLLOWING INCISION IN THE SEMILUNAR LINE FOR APPENDICITIS; FIRST OPERATION ELSEWHERE, OPERATION FOR HERNIA AND FLOATING KIDNEY IN GYNECOLOGICAL CLINIC.

J. H. H. J. R., æt. thirty. January 24, 1903. Recovery.

portion of the internal oblique and the transversalis, was split; the external oblique was then dissected away from its underlying structures for a distance of 2 inches over a vertical area 4 inches in length. Upon the inner side of the hernial opening the sheath of the rectus was laid open for a distance of $4\frac{1}{2}$ inches. The internal oblique and the transversalis were then

attached to the posterior layer of the rectus sheath by catgut sutures, while the body of the rectus muscle was dragged from its sheath and attached by mattress sutures to the under surface of the aponeurosis of the external oblique, so as to cover completely the site of the hernial pro-

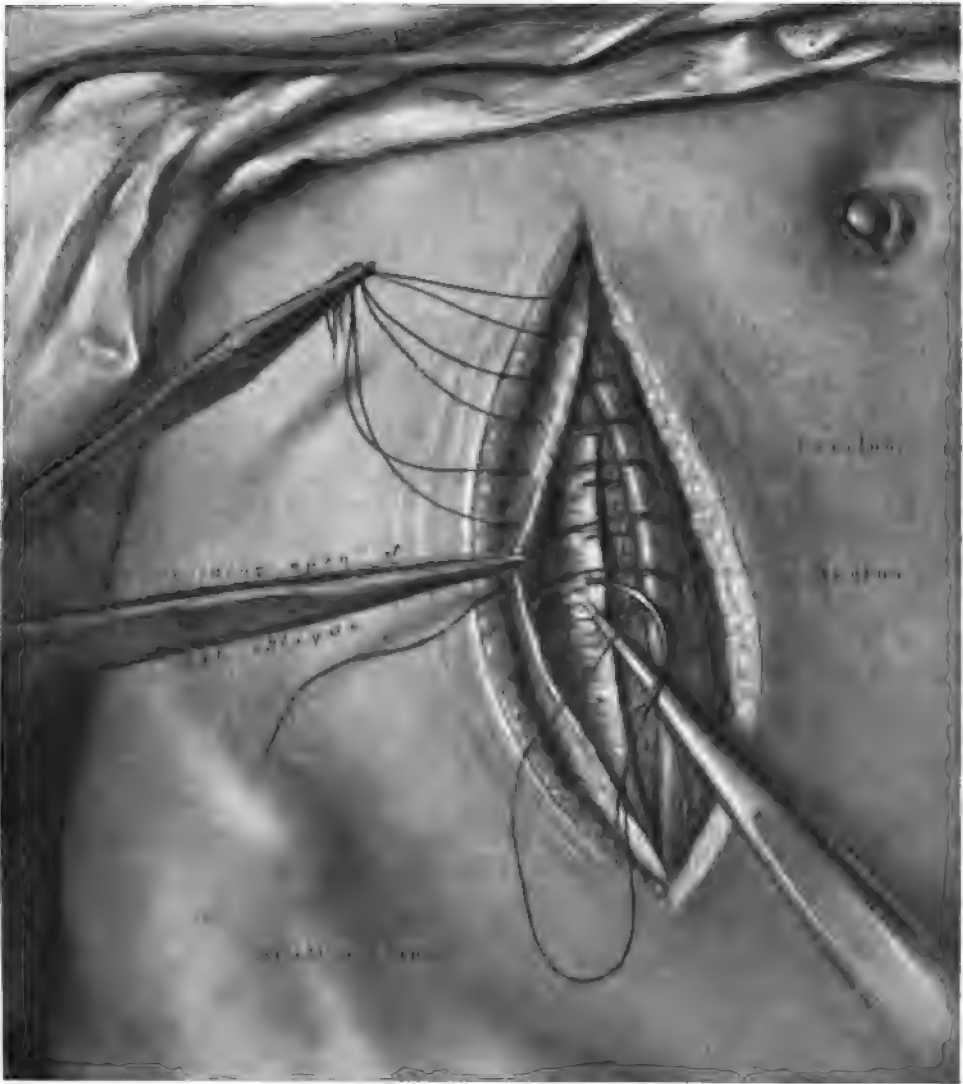


FIG. 179.—SHOWING OPERATION FOR HERNIA DOVETAILING RECTUS BETWEEN THE BROAD ABDOMINAL MUSCLES.

trusion. The free margin of the aponeurosis of the external oblique was then sutured onto the anterior surface of the rectus sheath, and, lastly, the skin wound was closed. Five months later there was no evidence of weakness in the region of the scar. The method of closure was not unlike that used in one of our own cases, which is here figured.

Fig. 178 shows the characteristic appearance of a large hernia in the right semilunar line; the drawing represents the flaccid scar filled in with thin skin. The larger opening in the diastasis is characteristically in the lower part of the wound. The incision, which had been made in another clinic, had evidently been closed by through-and-through sutures with drainage below. The method of closure is shown in Figs. 179 and 180.

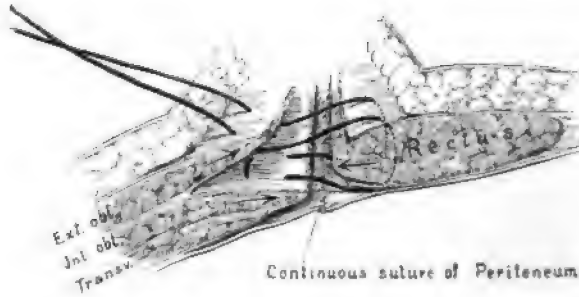


FIG. 180.—SHOWING IN DETAIL METHOD OF DRAWING RECTUS BETWEEN MUSCLES.

After dissecting out the scar tissue, the margin of the rectus muscle is exposed, clean and clear, throughout the entire length of the wound. The lateral muscles are likewise laid bare. The next step is to split the lateral muscles, separating the external oblique with its stronger fascia from the internal oblique and the transversalis below. The sutures are shown in full view in Fig. 179, while Fig. 180 exhibits the method of passing a single suture in profile.

CHAPTER XXI.

APPENDICITIS IN GYNECOLOGY AND OBSTETRICS.

RELATION BETWEEN APPENDICITIS AND GYNECOLOGICAL AFFECTIONS.

General Considerations.—POZZI, and also TERILLON, in 1890, emphasized the importance of the relationship between appendicitis and diseases of the pelvic organs in women, but it is only within the past eight or nine years that a general appreciation of this relationship has been manifested. Previous to this time, and even to a great extent to-day, the relative immunity of women to inflammation of the appendix has been chiefly dwelt upon, the exemption being partly attributed to the supposed accessory blood-supply from the ovarian vessels. Some writers, on the other hand, recognizing the coincident infection of the appendix and pelvic organs, believe that the infection has been conveyed from the one to the other through a pre-existing lymphatic connection between the appendix and the right ovary. It is now, however, generally conceded that the vascularization of the appendix is similar in the two sexes, and that an additional blood-supply from the ovarian or spermatic vessels, while occasionally observed, is very inconstant. It is also well recognized that diseases of the pelvic organs in women are often the chief factor in exciting an appendical attack, and, what is of still greater significance, that appendicitis is often the direct cause of tubal and ovarian disease, the secondary infection in either case being due to contiguity and not to continuity of structure. The confusion of diagnosis which frequently occurs between the two is of great importance, for patients suffering from chronic appendicitis are sometimes subjected to prolonged treatment for supposed pelvic disease, while, on the other hand, a case of acute salpingitis may be operated on for appendicitis. SIR FREDERICK TREVES (*Med. Chir. Trans. Lond.*, 1905, vol. 88, p. 434) found nine cases of coexisting ovarian troubles among the 55 cases in his own practice where operation for removal of the appendix failed to effect a cure of the symptoms. These cases had been operated upon by a variety of operators before he was consulted. I would especially emphasize the fact, mentioned elsewhere (see Chap. IX), that dysmenorrhoea is in many cases wholly due to the presence of a chronically inflamed appendix. It is partly due to mistaken diagnosis as well as to the failure to recognize the appendical origin of some cases of salpingo-ovaritis that appendicitis is found to be so much less frequent in women than in men. In Chap. IX it is noted that of the cases of uncomplicated acute appendicitis admitted to the surgical department of the Johns Hopkins Hospital, about 40 per cent. were women

and 60 per cent. men; but if we add the cases admitted to the gynecological clinic, usually with a diagnosis of pelvic disease, practically the same proportion obtains for the two sexes; while the cases of chronic appendicitis are in the ratio of 4 in females to 5 in males. I have not included in these statistics the cases of acute and chronic appendicitis which were associated with gynecological affections, but if these cases are added, out of a total of over 900 cases of appendical disease admitted to the Hospital, the number occurring in women is slightly greater than in men. It would appear, however, that the most severe forms, especially cases complicated with general peritonitis, are more common in the latter, occurring in the Johns Hopkins Hospital in the ratio of 2 to 5.

The relationship between disease of the vermiform appendix and disease of the pelvic organs in women may be either accidental or causal; and the most obvious classification of disease of the appendix from this point of view is the following:

1. Cases in which the disease of the appendix is *p r i m a r y*, and the pelvic affection is *s e c o n d a r y*, that is to say, consequent on the lesion of the appendix.

2. Cases in which the gynecological affection, whether it is tubal, uterine, or ovarian, is *p r i m a r y*, and the disease of the appendix is *s e c o n d a r y*.

3. Cases in which the disease of the pelvic organs and the disease of the appendix are *i n d e p e n d e n t* of each other.

In my clinic at the Johns Hopkins Hospital I have had occasion to remove the appendix in 240 cases, in the majority for combined gynecological and appendical disease. Prior to 1895 appendical adhesions observed during the course of a gynecological operation were often released and the appendix left *in situ*, but it is now my invariable custom to remove the appendix in these cases, unless the condition of the patient absolutely interdicts the slight additional strain. An analysis of the cases in which the appendix was removed is as follows:

Acute or chronic appendicitis not associated with gynecological affections.....	96 cases
Appendicitis associated with inflammation of the pelvic organs....	64 "
Appendicitis associated with retroflexion of the uterus (sometimes adherent).....	11 "
Appendicitis complicating ectopic gestation.....	7 "
Appendicitis associated with tuberculosis of the tubes and with secondary tubercular invasion of the appendix.....	4 "
Appendicitis associated with tuberculosis of the tubes, with simple adhesions of the appendix.....	3 "
Primary tuberculosis of the appendix.....	1 case
Appendix adherent to ovarian cysts.....	19 cases
Appendix adherent to ovarian myomata.....	15 "
Appendix adherent to malignant ovarian tumors, with secondary invasion of the appendix.....	2 "
Appendix adherent to malignant tumors, with simple adhesions of the appendix.....	1 case
Primary malignant disease of the appendix.....	1 "
Total.....	224

In the remaining 16 cases the appendix was removed either as a prophylactic measure, or (in three instances) on account of obscure pain in the right abdomen, without apparent disease.

1. APPENDICITIS ASSOCIATED WITH SECONDARY PELVIC INFLAMMATORY DISEASES.—Pelvic inflammation, the result of direct propagation from a right iliac abscess, is a common event, and is apparently more frequent in women than in men, probably owing to the greater number of cases in which the appendix occupies the pelvic position in women. As I have previously insisted, however, a pelvic abscess may form with an appendix high up in the iliac fossa. The great significance of this accident in women is that the uterus and its adnexa, particularly on the right side, may become implicated in the suppurative process with a resulting permanent impairment of their functions. Pus tubes and ovarian abscesses are not infrequent sequelæ of suppurative appendicitis, and in less severe cases the pelvic organs remain bound up in adhesions which are a frequent cause of persistent pelvic pain, severe dysmenorrhea, and sterility. A good example of the late effects of a suppurative peri-appendicitis (KRUGER, *Zeit. f. Chir.*, 1897, vol. 45) was the case of a woman, thirty-two years old, who was admitted with a pelvic disease, the result of several attacks of appendicitis. The appendix was removed and the abscess drained, the result being that the patient was cured of the appendical trouble but left with the uterus fixed in retroposition, while the tubes and ovaries, especially the right one, were fixed deep in the pelvis.

BARNSBY (*Thèse de Lyon*, 1898) relates the case of a woman aged twenty-five years, who gave no history of previous pelvic trouble, but had suffered from three attacks of appendicitis, the second and third terminating in the discharge of pus *per rectum*. Operation revealed a perforated appendix opening into an old inflammatory focus. There was an old abscess in Douglas' *cul-de-sac*, communicating with the rectum; double salpingitis, most pronounced on the right side, and the left ovary was adherent and sclero-cystic. The appendix and right tube were removed and it was then found necessary to extirpate the uterus to insure drainage.

One of my cases (Johns Hopkins Hospital, Gyn. No. 6502) was as follows:

The patient, who had had five normal childbirths, gave no history of pelvic disease. While in perfect health she was suddenly seized with severe abdominal pain, nausea and vomiting, and slight fever. The next day a lump appeared in the right side. She was in bed one month, and afterward suffered from pain in the right side which caused her to limp. Five months later there was a sudden exacerbation of the pain, attributed by the patient to the onset of the menstrual period; it soon subsided, but fearing to precipitate another attack, she remained in bed until she entered the hospital five weeks later. At operation the pelvis was found entirely walled off from the abdominal cavity and there was evidence of recent peritonitis involving the adjacent intestinal loops. Neither uterus nor tubes were visible. The appendix was visible only at its base, the tip extending into the plastic lymph walling off the pelvis. On bimanual examination *per vaginam* and through the opened abdominal cavity the uterus could be felt, but no mass suggesting the condition seen above. The adherent bowel was freed and the general peritoneal cavity packed off with gauze. The pelvic adhesions were carefully separated, the uterus being first freed. When the appendix was freed, pus was seen oozing from it. It was brought out and removed. The right tube and ovary were then inspected; the latter was found to be normal,

but the tube was swollen and engorged and its mesentery much thickened; it was, therefore, removed. As no streptococci were found in the exudate, the cavity was thoroughly cleansed with salt solution and the abdomen closed without drainage. Convalescence was absolutely smooth. Examination before discharge showed a natural abdomen; there was no resistance in the right pelvis, but on the left side slight bands of adhesions and an indefinite sense of resistance. I would now drain such a case.

ZWEIFEL especially directs attention to cases of appendicitis with a purulent exudate, which, reaching into the pelvis, involves the tubes and by sealing the abdominal ostia produces sterility. DUHRSSSEN, SHOEMAKER, and others believe that the perimetric adhesions due to appendicitis are a frequent cause of uterine displacements. In five out of the eleven cases in which I found appendical disease associated with retroflexion, the uterus was bound down by light adhesions which could not be accounted for by pelvic infection, and the uterine tubes were quite healthy. In these cases it was probable that an old appendicitis had been the cause of the perimetritis.

Unilateral disease of the adnexa is more commonly produced by appendicitis than bilateral affections. In exceptional instances, where a long appendix descends into and across the pelvis, the left tube and ovary are implicated. As a rule, however, the right adnexa are attacked, the left remaining perfectly healthy. In many of these cases the appendical origin of the infection is clear, both from the clinical history of the trouble and from the appearance of the organs at operation.

T. H. HAWKINS (*Med. Rec.*, May 6, 1899) describes two cases, observed in young girls, in which there was no history of pelvic trouble, and which presented a typical picture of acute appendicitis; operation showed the inflamed appendix caught up in the fimbriated end of the right tube, and a secondary acute purulent inflammation of the tube.

A very interesting case of appendical abscess discharging through the uterus is related by R. MORISON (*Lancet*, 1901, vol. 1, p. 533).

The importance of recognizing the presence of pelvic complications is seen in the following case. The patient, an unmarried woman, forty years old, was admitted with acute appendicitis. At operation there was no abscess and no pus nor fluid in the general cavity. A mass felt in the pelvis, supposed to be an enlarged right ovary, was not disturbed. There was slight pain and distention after operation, which on the third day began to increase somewhat, and the general condition was rather alarming; face flushed, pulse 103, temperature 100° F., respirations difficult. The wound was reopened and a large pelvic abscess was opened and drained. The mass which was felt at the first operation was also explored and found to be a tubo-ovarian abscess. Death occurred the following day.

In many instances it is difficult to determine the origin of the infection. The fact that the pelvic disease is limited to the right side is suggestive confirmatory evidence of the appendical origin, but the chief reliance must be placed on the history and on the condition found at operation.

2. APPENDICITIS SECONDARY TO PELVIC INFLAMMATION. — In the majority of instances in which there are coexisting affections of the pelvic

organs and the appendix the primary infection is in the pelvis. As a rule, the appendix is merely adherent by its distal portion, but more or less extensive pathological changes in its walls are frequently found. The appendix in woman, as we have said, frequently occupies the pelvic position and is in contact with the upper portion of the right broad ligament. In such a case a peri-salpingitis readily involves the peritoneal surface of the appendix. Moreover, in puerperal infection and in gonorrhœal salpingitis, when the large tube is higher than usual, the appendix may be involved even when situated above the pelvis. In a case described by BARNSBY (*loc. cit.*) the large, firm, turgid appendix was densely adherent to the posterior surface of an enormous tubo-ovarian abscess which extended almost to the

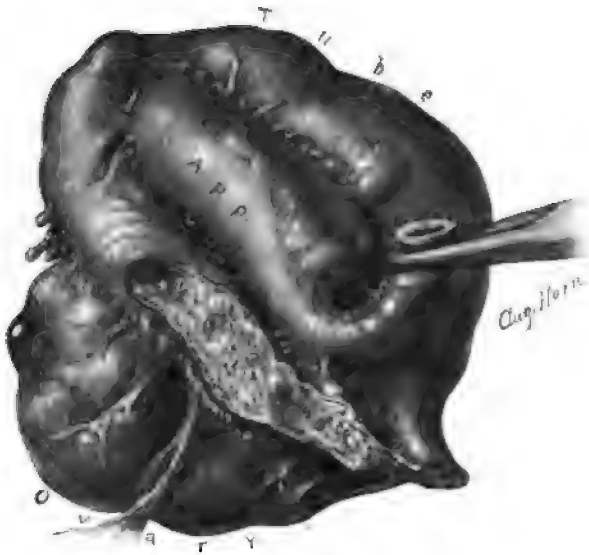


FIG. 181.—H. A. KELLY. INFLAMED APPENDIX ADHERENT TO A TUBO-OVARIAN ABSCESS. (Gyn. Path. No. 5622.)

umbilicus. Usually, as I have said, the appendix is attached to the tubo-ovarian mass merely by more or less firm adhesions; sometimes by a delicate strand of tissue extending from the tip of the appendix to the pelvic mass, the appendix itself showing practically no gross changes. But careful examination of such appendices shows that comparatively few are perfectly healthy, a mild catarrhal inflammation being most often met with. More severe lesions, however, are not unusual, an unsuspected acute diffuse inflammation being found in some instances at operation; but more often a chronic inflammation or various residual conditions—viz., strictures, obliteration, or cystic distention—are present.

In the case represented in Fig. 181 the patient had had the left ovary removed two years before for inflammation, dating from her second confinement nine years previously. The pain, however, continued in both sides of the abdomen but was more intense in the right side. Operation

revealed a large inflammatory tubo-ovarian mass in the right side, with the thickened, chronically inflamed appendix densely adherent over its surface. In another case (Gyn. No. 9560) the patient had suffered for fifteen years (since her last pregnancy) from leucorrhœa and neuralgic pains in her thighs and legs and from constipation. There was no history of appendicitis. At operation an old inflammatory condition of the pelvic organs was found. The right tube was irregularly distended with clear

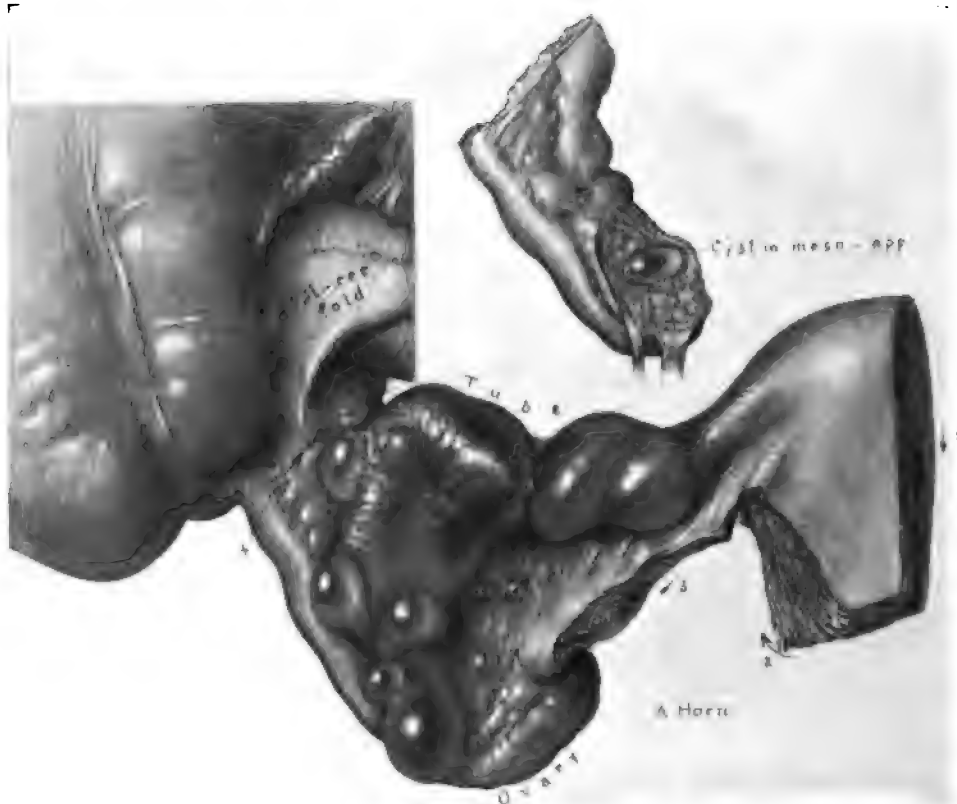


FIG. 182.—H. A. KELLY. OBLITERATED APPENDIX ADHERENT TO A CHRONIC TUBO-OVARIAN INFLAMMATORY MASS. (Gyn. Path. No. 5742.)

fluid, its surface was covered with dense adhesions, and showed many sub-peritoneal cysts. The appendix was densely adherent to the uterine tube by its mesentery, which also contained a small peritoneal cyst (see Fig. 182).

In one of my cases (Gyn. No. 3650) a left pyosalpinx was removed, but as the right tube was free and only slightly reddened, it was left *in situ*. The patient was discharged apparently well. A few days later, however, she returned with a mass on the right side. Operation showed the tube distended with pus, and the reddened, fluctuant appendix adherent to it. Removal of the tube and appendix resulted in complete cure.

The causal relation of the pelvic disease to the appendical inflammation may be direct or indirect. In the first, the appendix in the beginning becomes involved in the pelvic exudate, the adhesions thus formed become organized, and then, lymph and blood-vascular connections being established between the appendix and the tube, the infection is easily transmitted. It seems probable, however, that usually the pelvic disease, by fixing the appendix in adhesions, limits its movements and by inducing stasis acts as a predisposing factor in the development of the appendicitis. The bacteriologic proof of the mode of infection is generally unsatisfactory, as an old pelvic inflammatory focus is often secondarily invaded by the bacillus coli, and streptococci are present in most cases of acute appendicitis. In a case in my clinic reported by H. ROBB (*Johns Hopkins Hospital Bull.*, 1892), in which there was a history of pelvic disease, and at operation double pus tubes were found with the inflamed appendix adherent to the one on the right side, the fact that a pure culture of streptococcus was obtained from both the tube and the appendix suggests the direct infection of the appendix from the tube.

The history of the onset and course of the disease is the most important point in determining its original focus. It is frequently possible to obtain a clear history of puerperal or gonorrhœal infection accounting for the pelvic disease, and in these cases, as a rule, clinical evidence of the appendical complication is conspicuously absent.

Tuberculosis of the pelvic organs not infrequently involves the appendix in the peritoneal adhesions which usually accompany this condition, and in a number of these cases the appendical walls are invaded by the tubercular process, even where there is no evidence of other extension of the disease. Out of 7 cases, examined by myself, in which the appendix was adherent to the tubercular tube, in 4 the appendix was slightly infiltrated with tubercles. A circumscribed tubercular peritonitis was present in only one of these instances. These cases are more fully considered in Chapter XVI.

Tumors of the uterus and ovaries, complicated by disease of the appendix. Cases in which the appendix is adherent to cysts of the right ovary are frequently observed, and occasionally it is found attached to a left ovarian cyst (see Fig. 183). Out of about 300 operations for cystoma in the Johns Hopkins Hospital, the appendix was found adherent to tumors of the right side in 16 cases and to those of the left side in 3. In some instances the appendix is merely secondarily involved in the general adhesions which so frequently surround pelvic tumors and are the residue of an old widespread peritoneal reaction. Dermoids and cysts with torsion of the pedicle are particularly liable to give rise to general adhesions, and it is in such cases that the appendix is most often involved. In our series the cyst had become twisted on its axis in one-fourth of the cases, and in these the appendical adhesions were unusually dense and extensive. In other instances the appendix is adherent to the otherwise smooth surface of the cyst

or to the broad ligament. It is probable, however, that the direct mechanical influence of the tumor, by disturbing the relations of the appendix, by interfering with its circulation, or by direct pressure, has indirectly excited a mild diffuse inflammation of the appendix with extension to the peritoneum. It is readily seen how such an effect would be produced when the appendix occupies the pelvic position and is subject to direct pressure of the tumor. In some cases the tip only is adherent; in others the entire appendix, including its mesentery, is plastered to the surface of the tumor. The organ itself may be practically normal, but, as a rule, its walls are

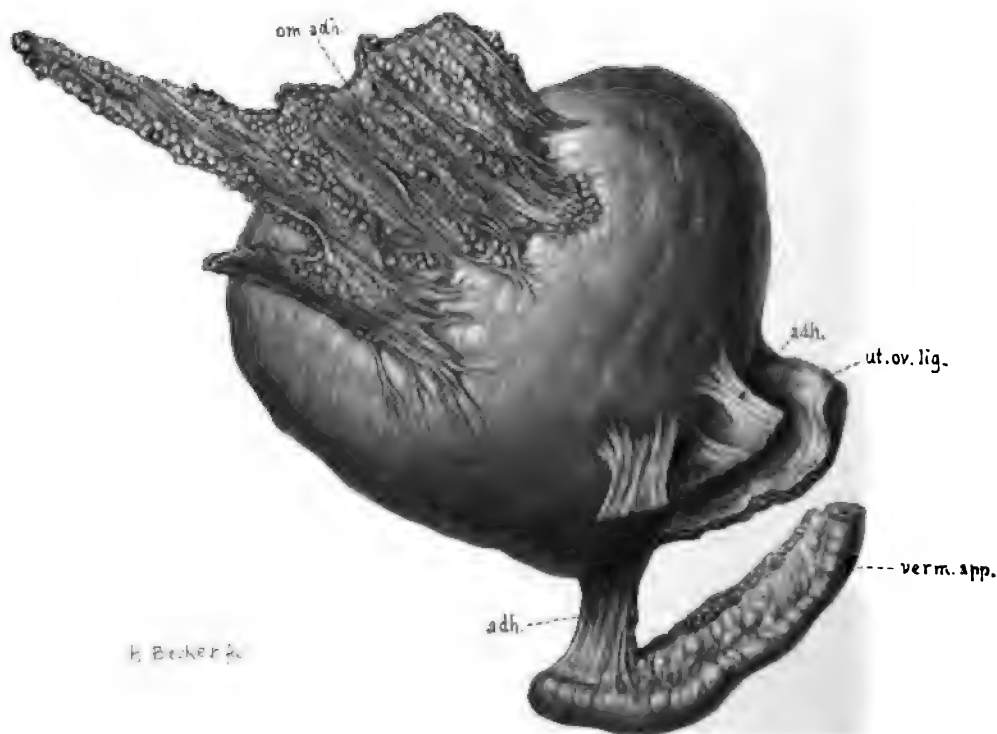


FIG. 183.—H. A. KELLY. TIP OF THE APPENDIX ADHERENT TO SMALL DERMOID CYST OF LEFT SIDE.

Note also omental adhesions above. Appendicitis, cholecystitis. S., age fifty-four, Feb. 6, 1899. Recovery.

thickened and rigid, while kinks, twists, strictures, and other results of an inflammatory process are commonly found. In two instances of ovarian cysts I found the appendix stenosed near its base, and the remainder converted into a large transparent cyst. Acute appendicitis may develop and cause secondary infection of the cyst wall. In 3 cases described by X. O. WERDER (*Jour. Amer. Med. Assoc.*, Jan. 1, 1898) acute appendicitis complicating ovarian cysts gave rise to symptoms simulating torsion of the pedicle. In all the cyst wall was congested and apparently involved in a secondary infection from the appendix; in one the sac was dark and exceedingly friable. WIKERSHAUSER (cited by Pollak, *Centrbl. f. d. Grenzbl.*

d. Med. u. Chir., vol. 7, p. 161) reports a case of large suppurating ovarian cyst with firmly adherent appendix, and was of opinion that the infection had extended from the appendix to the tumor. In one of the Johns Hopkins Hospital cases the appendix, together with the cæcum, was attached by its entire length to a suppurating cyst of the left ovary.

Parovarian cysts are equally disposed to be complicated by appendical adhesions, or by acute or chronic appendicitis. In a case described by KRÜGER (*loc. cit.*, Case 12) the patient, a girl nineteen years old, gave a history of recurrent attacks of appendicitis extending over a period of two years. When admitted, during the third severe attack, there was tenderness in both hypogastric regions, with dulness and marked resistance. In the left side fluctuation was detected. At operation a right parovarian cyst, with its pedicle twisted two and a half times, was found lying in the left abdomen. The appendix, which was 12 to 13 cm. long, deep red, and injected, descended into the pelvis, where it was adherent by its tip. In the case of malignant ovarian tumors the appendix may become adherent and be secondarily invaded by the new-growth. These cases, as well as the occurrence of metastatic growths in the appendix secondary to ovarian tumors, are considered in Chapter XVI.

Uterine myomata are less frequently complicated by disease of the appendix than ovarian cysts. In some 500 myomectomies the appendix was adherent in about 3 per cent. As in ovarian tumors, the appendix usually presents evidence of chronic inflammatory changes. In one case (Johns Hopkins Hospital, Gyn. No. 5302) the patient, a woman forty-six years old, was suddenly seized ten days before admission, while enjoying good health, with pain in the right lower abdomen, associated with dysuria and constipation. At operation the large myomatous uterus was found densely adherent to the pelvic floor, the sigmoid flexure, the rectum, and the colon, while the appendix was entirely embedded in a tubo-ovarian abscess on the right side. In another case DOLÉRIS (Pollak) removed a suppurating myoma *per vaginam*, death occurring a week later, when the postmortem showed a perforated gangrenous appendix lying in the centre of an abscess, encapsulated amidst coils of intestine. Fig. 184 shows the appendix adherent to a large uterine myoma which exhibited sarcomatous changes.

Ectopic gestation is complicated with appendicitis in a considerable number of cases. Personally I recall seven instances, forming about 10 per cent. of the cases of extra-uterine pregnancy observed in my clinic, in which the appendix was adherent to the sac, or was acutely inflamed. In one case the patient had an old, inflammatory, pelvic disease binding down both tubes and ovaries, and, grafted on this, an extra-uterine pregnancy with adhesions. A very difficult enucleation was done by bisection (see Fig. 185). The patient died shortly afterward, seemingly of collapse. The great danger in these cases lies in the infection of the products of conception by the appendicitis. KRÜGER describes the case of a woman, aged thirty, with a history of acute appendicitis beginning four weeks

previous to admission. Menstruation was regular; her temperature was 99.1° F.; her pulse 120. Incision in the right flank exposed the abdominal



FIG. 184.—H. A. KELLY. APPENDIX DENSELY ADHERENT TO FIBROID TUMOR, UNDERGOING SARCOMATOUS DEGENERATION.

Note the displacement of the ileum and the adhesions of the uterine tube and ovary. Appendix 13 cm. long, and contained many small concretions. E. M., age fifty-six. Death without operation. Autopsy. April 24, 1898. (Path. No. 1085.) (Natural size.) (See p. 409.)

cavity filled with large clots. The thickened, reddened appendix was firmly bound to the gestation sac, and it was evident that infection of the contents

of the hæmatocele had occurred. Enucleation of the sac and the appendix was followed by a smooth recovery. A very interesting case is related by SUMMA (*St. Louis Cour. of Med.*, 1900, p. 434), in which, after the appendix had been extirpated at an operation for acute perforative appendicitis, a severe hemorrhage suddenly welled up from the depth of the pelvis. Investigation of the cause of this accident revealed a fresh rupture of an ectopic pregnancy on the left side, a one month's foetus being found.

In a case observed in the Johns Hopkins Hospital (Gyn. No. 4576) the patient, aged thirty-eight years, entered with a history of having fainted one week before while hanging up clothes, having since had continuous hemorrhage. As the patient was subject to attacks of syncope, this attack

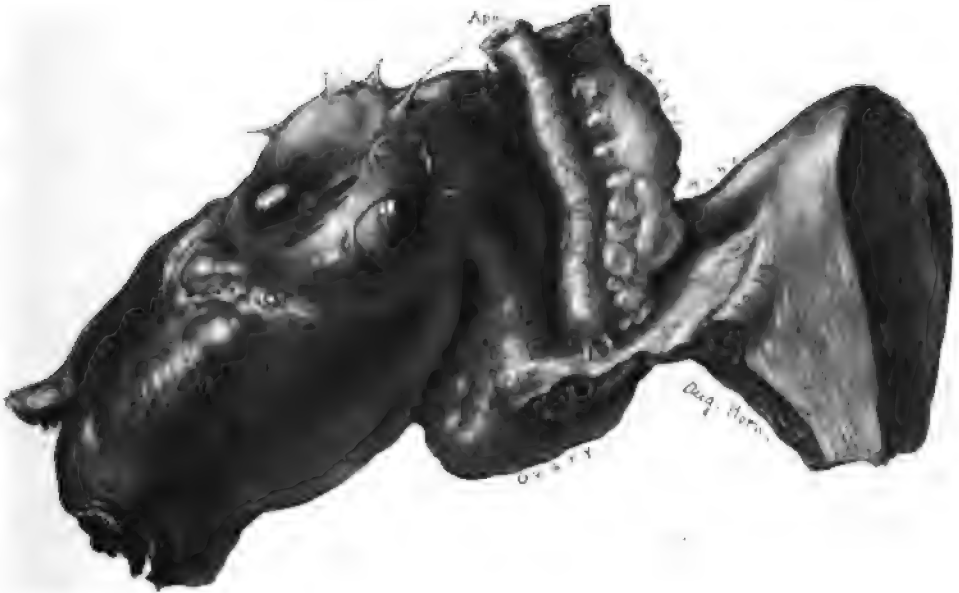


FIG. 185.—APPENDIX ADHERENT TO RIGHT BROAD LIGAMENT IN A RIGHT EXTRA-UTERINE PREGNANCY. (M. A. Runyon. *Orange, N. J.*, Feb. 14, 1903.)

The ampulla of the uterine tube is distended with clots, and the appendix adherent in the angle between the ampulla and the isthmus. (Natural size.) (See p. 409.)

did not alarm her, and was ascribed to the heat. There was pain about the umbilicus and in the inguinal regions, especially the right. Temperature 100° F.; pulse 100. Operation showed a recently ruptured, right tubal pregnancy, and an acutely inflamed appendix.

3. INDEPENDENT AFFECTIONS OF THE APPENDIX AND THE PELVIC ORGANS.—In cases falling under the third class—namely, those in which disease of the appendix and disease of the pelvic organs exist independently, and their association is purely fortuitous—the affection of the appendix is, as a rule, an old one. The appendix will be found attached to adjacent structures, or, as I have often seen it in the course of gynecological operations, completely atrophied and even reduced to a fine cord, in some instances no

more than a filament. On the other hand, unsuspected disease of the uterus, tubes, or ovaries, associated with the remains of an old pelvic peritonitis, may be of long standing and only discovered unexpectedly during the course of an operation for acute appendicitis. It is not always an easy matter in inflammatory cases to decide whether disease of the appendix and the right tube and ovary are independent or associated, for extensive inflammatory affections proceeding from the vermiform appendix or from the uterine tube may spread from one organ to the other and then subside, leaving traces behind in the form of adhesions enveloping both organs. In these circumstances reliance must be placed on the history of the case, which should always be carefully investigated.

The possibility of the coexistence of pelvic and appendical disease should always be borne in mind, especially in cases which are being treated for pelvic disease. The cure of the pelvic affection in such instances has disappointing results, and the patient continues to suffer from much of the discomfort and pain for which she was treated, relief being finally obtained only upon removal of the appendix. A good example is the case of a patient who came under my care suffering from general pelvic discomfort and painful menstruation. I made a median incision and found the uterus retroflexed and the ovaries adherent. The adhesions were freed and the uterus suspended. The patient was little, if at all, improved by my treatment. Some months later she was operated on by J. B. DEEVER of Philadelphia, who removed the chronically inflamed appendix, with the complete relief of all her previous symptoms. WIGGIN (*N. Y. Med. Jour.*, 1894) operated upon a woman for double pyosalpinx and general pelvic peritonitis resulting from puerperal infection. The appendix was not examined, as the intestinal adhesions were light and easily separated. At the end of the third day after operation, the patient suddenly presented the typical symptoms of acute appendicitis, and at operation the following day a large quantity of fetid pus was evacuated while the adherent, perforated appendix was removed. The author believed that the appendix was diseased at the time of the previous operation and that the trauma during the operative manipulations had excited the acute attack. DELAGÉNIÈRE (*Congrès de chir.*, 1897) relates the case of a woman who had had the right ovary, which was sclero-cystic, removed and the uterus suspended on account of pain in the abdomen coincident with the menstrual periods which dated from a childbirth five years before. Six weeks later she was attacked with symptoms of appendicitis, and shortly afterward had a second attack. Operation revealed an adherent and chronically ulcerated appendix, associated with the presence of concretions.

Quite often, after the removal of uterine or ovarian tumors, which are not complicated by adhesions, investigation of the cæcal region will reveal the presence of independent appendical disease. Thus, in one case after removing a non-adherent ovarian cyst, I found the appendix converted into a translucent, cucumber-shaped cyst. In a case of myoma the appendix was found completely filled and distended by two large concretions;

in another case of myoma the appendix was obliterated and enveloped in adhesions. In cases of ectopic gestation the association of an independent appendicitis has been frequently observed, as in the case of SUMMA, mentioned above.

Diagnosis.—The greatest interest in regard to the relationship existing between disease of the pelvic organs and appendicitis centres in the diagnosis. The questions to be determined are: Is the case one of pelvic disease, is it one of appendicitis, or is it one of coincident appendical and pelvic disease? In many instances the differential diagnosis is of interest chiefly from its bearing upon the technic of the operation, as in any case surgical intervention is imperative, but in other cases it is of the utmost importance that a correct diagnosis should be made; as, for example, if we are dealing with a case of early acute salpingitis, palliative treatment may be indicated; whereas, if it is a case of acute appendicitis, conservative treatment may result in the death of the patient.

Inflammatory diseases of the right uterine adnexa are most frequently confounded with appendicitis. With an accurate history of the onset of the malady and a careful physical examination, mistakes should seldom occur, since both diseases present such characteristic differences. In the history of the development of acute pelvic infection it will usually be found that there has been a yellowish vaginal discharge, often associated with burning micturition, for a longer or shorter period before the acute symptoms appeared; whereas in appendicitis a history of previous attacks of pain in the right side or of digestive disturbances is often given. Abdominal pain associated with nausea and vomiting may appear as suddenly in disease of the adnexa as in appendicitis, and there may be local pain on pressure over the right lower abdomen; but the local pain and tenderness are usually situated more deeply in the pelvis and right inguinal regions, the most intense pain being elicited on deep palpation in the region of Poupart's ligament. On vaginal examination exquisite tenderness is felt on one or the other side of the uterus. If the tenderness is equal on both sides or if it is most marked on the left side, perimetritis is suggested. R. J. MORRIS has called attention to the diagnostic importance of tenderness on pressure at a point an inch and a half from the umbilicus in a line drawn from the navel to the right anterior superior spine of the ilium. That is at the same distance from the umbilicus that McBurney's point is from the anterior superior spine. In chronic appendicitis tenderness is invariably present at this point, whereas in pelvic disease there is tenderness at the corresponding point on the left side. Therefore, if both appendicitis and pelvic inflammation are present, both of Morris's points will be tender; if there is pelvic inflammation alone, the left Morris point will be tender; while if it is appendicitis alone, the right Morris point is sensitive. DR. MORRIS has found this sign of great value in differentiating between the two affections. It is, however, in just those cases where the appendix occupies the pelvic position, even extending

to the left side, and in which the pain and tenderness are referred to a point deep down in the pelvis or inguinal region, that confusion is apt to exist. One of the most characteristic differences in the early stage of the attack is found in the character of the pain, which at the onset of appendicitis is usually paroxysmal, while in pelvic inflammation it is more steady and less intense. Fever, accelerated pulse, and leucocytosis offer no points of differentiation. Chills are more common in appendical inflammation, but are very inconstant. The relation of the attack to the menstrual periods is often the cause of error, which sometimes leads to a fatal delay in surgical intervention. The two following cases illustrate this point.

C. K. LEMON. (*Personal communication.*) The patient was seized with an acute attack of appendicitis associated with suppression of the menstrual flow, on the second day of the period. The presence of pain in the lower abdomen, slight fever, and constipation led to a diagnosis of acute congestion of the uterus, and the patient was treated with laxatives and hot applications. When seen by a consultant on the fourth day, there was great distention, high temperature, and complete obstipation, soon followed by incessant vomiting, which became stercoraceous. Death occurred on the sixth day. An important clue in the early diagnosis in this case was the history of several previous attacks of pain in the lower abdomen, the first of which antedated the beginning of the catamenia.

G. I. McKELWAY. (*Med. and Surg. Rep.*, 1892, p. 603.) A young unmarried woman suffered from excruciating pain in the right ovarian region at every menstrual period and constant tenderness on pressure. She became pale and weak and was unable to work. A vaginal examination showed a retroverted uterus, bound down by adhesions, and an exceedingly sensitive, adherent mass the size of a walnut, to the right of the uterus. Abdominal section showed an adherent uterus, a normal tube and ovary on the left side, and an appendix greatly enlarged and tense, which was adherent to the right tube and ovary, occasioning the sensitive mass palpated in the examination. The tube and ovary, which apart from the appendical adhesions, were healthy, were freed and left *in situ* and the uterus was freed. The appendix was removed, and the patient made a perfect recovery, with the uterus in the normal position and no lateral mass.

The development of pelvic inflammation in a young girl or an unmarried woman of good character should always arouse a suspicion of primary appendical disease, even when the bimanual examination shows definite disease of the adnexa on one or both sides, as in many cases it will be found that a tubo-ovarian disease is due to a secondary infection from the appendix.

In the early stage of either affection a tumor cannot usually be detected; later, a more or less well-defined resistance posterior or lateral to the uterus may signify a pelvic inflammation or pelvic appendicitis. In the latter the resistance is usually situated higher, extending from the posterior border of the right broad ligament toward the iliac fossa, and the broad ligament itself is free. In pelvic disease the tumor is deep in the pelvis, and it is often possible to palpate the thickened uterine end of the tube and to trace it out to the mass. An interesting case has been reported by BARNSBY (*loc. cit.*).

In other cases a large pyosalpinx may extend up into the iliac fossa and closely simulate an appendical abscess.

Acute pelvic inflammation accompanied with spreading or generalized peritonitis in the absence of a clear history, cannot usually be differentiated from appendicitis. In two cases admitted to the Johns Hopkins Hospital a diagnosis of appendicitis with diffuse peritonitis was made, but at operation a gener-

alized peritonitis originating from acute gonorrhœal salpingitis was found. ("The Vermiform Appendix and its Diseases," p. 713.)

In both of these cases, notwithstanding the definite history of venereal exposure, prominence of the abdominal symptoms and absence of pelvic symptoms occasioned a wrong diagnosis.

In another case diffuse peritonitis resulting from a ruptured right pyosalpinx was mistaken for acute appendicitis. SIEGEL (cited by Pollak) found a ruptured ovarian abscess at operation upon a case in which a diagnosis of perforative appendicitis had been made. FENWICK (*Lancet*, 1897) reports a case of ruptured pyosalpinx mistaken for appendicitis. A pelvic abscess, whether originating from the generative organs or from the appendix, presents no distinctive features, and in either case there may be a complete absence of abdominal pain and tenderness. The history of preceding vulvo-vaginitis or of puerperal infection on the one hand, or of attacks of right iliac pain on the other, is a most important guide to a diagnosis.

A. E. GALLANT (*Amer. Med.*, 1903, No. 1, 836) describes two very interesting cases in children, one ten years old, the other thirteen, in which a retroperitoneal appendical abscess burrowed down in the recto-vaginal septum and formed a bulging tumor at the outlet. A diagnosis of pelvic disease was made and laparotomy performed, but in each case the pelvic organs and peritoneum were absolutely healthy. MUNDÉ (*Med. News*, 1897, p. 621) describes a similar case; a well-defined elastic swelling in the median line of the abdomen was taken for an ovarian cyst. A median incision showed the uterus and appendages normal and the swelling retroperitoneal. The incision was closed and a vaginal examination, neglected before, revealed a tense protrusion of the posterior wall. On opening this, a large quantity of fetid pus escaped, and a probe introduced into the abscess cavity passed readily up to the crest of the right ilium.

Confusion in the diagnosis between appendicitis and ovarian cyst with torsion of the pedicle is very common. NIOT (*Thèse de Paris*, 1901) cites 11 instances of dermoid cysts with twisted pedicle, mistaken for appendicitis. In 2 out of 5 cases of cyst with twisted pedicle observed by FOWLER, the patient was sent into the hospital with a diagnosis of appendicitis. As a guide to the differential diagnosis a previous knowledge of the existence of the tumor is of the greatest importance. It happens, however, that acute torsion is most common in the case of cysts of medium size, which had not previously produced any visible swelling, the subjective symptoms being absent or else very slight. The frequent association of constipation with pelvic tumors leads rather in the wrong direction in considering the diagnosis. The sudden onset of severe pain, often accompanied with nausea and vomiting, may closely simulate acute appendicitis. The chief distinguishing features of torsion of an ovarian pedicle are the character of the pain, which is more continuous and diffuse, unlike the colicky initial pain of appendicitis, with its later localization in the right iliac fossa. At a later stage when peritonitis supervenes, the subjective symptoms are very

similar. Palpation is the most valuable means of differentiation. It is sometimes possible at the very outset to distinguish the rounded, well-defined, elastic ovarian tumor, while in appendicitis a mass is rarely observed in the early stages, and, if it is, has not the sharp contour of the cyst. Fluctuation in the case of dermoids and some multilocular cysts is often indefinite, and never to be depended upon. In many cases, however, the distention and extreme sensitiveness of the abdomen render palpation very unsatisfactory, and the cyst may be completely masked by the rigid abdominal walls. Percussion may then be serviceable in outlining the tumor. As the early acute reaction subsides, the tumor is sometimes readily palpable; whereas in appendicitis not complicated with diffuse peritonitis the abdomen becomes natural-looking and soft, with the exception of the appendical region. In either case, however, peritonitis may complicate the situation. In this event a differential diagnosis is sometimes impossible, but, in general, it may be noted that the peritonitis accompanying ovarian cyst is of a milder type, and is not associated with the severe constitutional symptoms of peritonitis originating from appendicitis. Moreover, the abdominal tenderness is usually less pronounced. Examination *per vaginam* and *per rectum* will sometimes give valuable information regarding the malady, and it may in this way be possible not only to outline the cyst, but also to recognize the twisted pedicle, which is felt extending from the side of the uterus up to the abdominal mass. If the tumor is entirely intra-abdominal, the uterus may be displaced upward. As in either condition operative interference is imperative, the differential diagnosis is not of great importance except as a guide to the incision; and, as a rule, when the patient is anæsthetized the tumor is easily recognized if a bimanual examination is made. It is advisable in making the rectal examination immediately before operation to protect the hands with rubber gloves.

The diagnosis between a ruptured tubal pregnancy and a p p e n d i c i t i s is seldom difficult, if an accurate account of the events leading up to the attack can be obtained, as well as a clear description of its onset. The history of irregular menstruation, especially the statement that a period has been delayed for a week or more, with a subsequent slight, irregular flow, is very suggestive of tubal pregnancy. The onset of the attack with sudden agonizing pain, followed almost immediately by fainting and marked pallor, is pathognomonic. Chills, vomiting, and sudden evacuation of the bowels may occur at the onset of ruptured tubal pregnancy or with acute perforative appendicitis. Tenderness and muscle spasm on palpation over the right iliac region may be observed in a right tubal pregnancy; usually, however, the local signs are situated deeper in the pelvis. On bimanual examination the enlarged tube is usually palpated. Finally, it may be said that the most important point in arriving at a correct diagnosis is the recognition of the fact that confusion may exist, and that it is necessary to examine the pelvic organs carefully to exclude pregnancy.

DIAGNOSIS OF COEXISTING AFFECTIONS.—An important question to be determined in some cases in which the presence of the gynecological affection

is well recognized, is whether there is a complicating appendicitis. The fact that the appendix is frequently involved in pelvic adhesions is now too well known to require especial emphasis, and at the present time it is improbable that such accidents could occur as were reported by TAIT and WIGGIN, in which, during the course of an operation upon the pelvic organs, the appendix, which was involved in the universal dense adhesions, was severed without the knowledge of the operator, the fact only being discovered on the postmortem table. It must be remembered, however, that independent affections, acute or chronic, may coexist, and that one may be masked by the predominant symptoms of the other. This is of especial importance in the case of acute appendicitis developing during the course of an acute pelvic inflammation. The greater severity of the abdominal and general constitutional symptoms, the paroxysmal pain, and the localization at or near McBurney's point, should suggest this complication. In doubtful cases an exploratory section entails less risk than delaying the operation until the diagnosis is clear. Moreover, when pelvic inflammatory disease is attended with increasing abdominal pain, tenderness, and rigidity, operative interference is usually indicated. An abdominal section is preferable to the vaginal route in all cases where there is a possibility of error. Acute appendicitis occurring in a patient who is known to be the subject of an ovarian cyst would naturally suggest a torsion of the pedicle, as in three cases recorded by WERDER (*loc. cit.*). Fortunately, the differential diagnosis in such a case is not of great importance, as early operation is indicated in either case, and the condition is then easily recognized. The coexistence of appendicitis and extra-uterine pregnancy is usually recognized if a careful history of the case is obtained and a thorough abdominal and bimanual examination made. Both affections present such a characteristic clinical history that even when associated, mistakes should not often occur. The greatest danger lies in the fact that when an acute appendicitis exists at the same time as an unruptured tubal pregnancy which has not given rise to any pronounced symptoms the operator may not be aware of its presence. In one case of a young unmarried woman, giving a definite history of recurrent appendicitis, there was also a history of irregular menstrual flow for about three weeks, and on vaginal examination the tube seemed to be thickened. After removing the chronically inflamed appendix I also removed an early, unruptured, tubal pregnancy.

Treatment.—EXAMINATION OF THE APPENDIX WHENEVER THE ABDOMEN IS OPENED.—The frequency with which disease of the appendix is associated with disease of the pelvic organs affords a sufficient reason for examination of the appendix whenever the abdomen is opened for any reason whatever. I have elsewhere emphasized the duty incumbent upon every surgeon of utilizing the opportunity afforded by abdominal section to examine the appendix whenever it can be done without additional risk.* For the last eleven years I have made it my invariable practice not only to examine

* "The exploration of the abdomen as an adjunct to every celiotomy." *Med. News*, December 16, 1899.

the appendix, but to note its condition as regards length, soundness, and freedom from adhesions, including these data among others which the anæsthetizer is expected to fill in upon a printed slip.

REMOVAL OF THE APPENDIX AS A PROPHYLACTIC MEASURE.—The first question which arises at this point is whether the normal appendix should be removed as a prophylactic measure whenever the opportunity to do so is afforded by abdominal section. During the time this book has been in preparation I have discussed the question with various friends, and I find that the greatest diversity of opinion exists among them in regard to it, some of them urging the radical plan of removal in every case, and others condemning such a practice as meddlesome and unsurgical. The variance of opinion among men of equal ability and experience was indeed so striking that I believed it would be both of use and of interest to investigate and make known the views of a number of professional men upon the subject. I wrote, therefore, to 80 well-known surgeons in different parts of the United States, asking for their opinions and requesting permission to publish them. The method of interrogation which I used was to send each individual a return postal card with the following question: *When the abdomen is opened for other causes and the perfectly normal appendix is easily accessible, is it your rule to remove it?*

To 80 applications I received 74 replies, which have been published elsewhere in some detail (*Jour. Amer. Med. Assoc.*, Oct. 25, 1902). It is evident from them that no uniformity of opinion exists among medical men as to the conditions under which the appendix should or should not be removed. One surgeon of ability and experience, for instance, replies: "Yes, always"; while another, whose opinion is no less entitled to consideration, answers: "No, it is unsurgical." The categorical form of my inquiry, of course, made it impossible for surgeons to qualify their answers, as some of them, apparently, wished to do. In classifying the replies, I have treated answers such as "Usually, but not always," or "If the patient's condition permits," as unqualified, since I asked only for the rule, not the exception; and I assume in my question that no serious contraindication is present. A few answers, however, were received which could not be classified unreservedly as either affirmative or negative.

Exclusive of these, there were 70 replies, 44 of which were against removing the normal appendix and 26 in favor of doing so.

Assuming these results to represent a general consensus of opinion throughout the United States, they show a decided majority (44 to 26) against the removal of the normal appendix, simply because the opportunity to do so is present. My own opinion coincides entirely with this view. I never remove the appendix in the course of the operation for other causes, when it proves on inspection to be entirely normal; and my reasons for this position are as follows:

1. The removal of the appendix involves a slight additional risk, owing to the fact that no matter how good the patient's condition may

be at the time of the removal there is no guarantee that it will remain so until the end of the operation; and should a condition of shock ensue, the additional five minutes thus consumed will lessen the patient's chances of recovery.

2. We are not yet in a position to estimate the importance of removing the normal appendix as a prophylactic measure, for statistics have not yet made it evident what is the exact risk of an attack of appendicitis to each individual in the community.

3. The fact that the appendix has no known function does not prove that it is a functionless organ, although we are in the habit of calling it so; and it is within the bounds of possibility that an increase in our knowledge concerning it in the future may demonstrate some reason for its preservation. It is only a few years since the ovaries were considered to have no use or purpose besides that of reproduction, and their extirpation, apart from interference with their primary function, was a matter of no importance. Now, however, when their relation to the process of internal secretion is beginning to be understood, we find ourselves responsible for their preservation for entirely other reasons.

Removal of the Adherent Appendix.—I availed myself of the opportunity afforded by the above inquiry to ascertain also the opinion generally held as to the advisability of removing the vermiform appendix when it is adherent, or, in other words, when it deviates in the slightest degree possible from normal. I appended a second question to the following effect: *When the appendix is even slightly adherent to neighboring structures, peritoneum, ovarian, or fibroid tumors, do you then remove it?* To this query I received 7 answers so qualified that they could not be classified. Out of the remaining 67 answers, 60 were in favor of removing the appendix under the conditions specified, and 7 were against it. It will be seen that the majority in favor of removing the appendix under the conditions is very large, so large as to constitute almost unanimity of opinion. For myself, I believe it to be an excellent general rule to remove the appendix whenever it is adherent to another organ, because it is prone to bleed, and if returned to the abdomen, may very readily contract adhesions which may cause an attack of appendicitis. I also think it a good special rule to remove any appendix which hangs free from the end of the cæcum, as well as one which is long enough to reach the field of an adjacent operation, because such appendices are specially liable to become adherent. I do not, however, remove a short appendix, nor one which is curled up on either side of the cæcum, and I would carefully avoid pulling out an appendix which lies above the horizontal line traversing the lower end of the cæcum. In this connection I should also like to recall and to endorse the opinion of R. ABBÉ, namely, that the perfectly normal appendix never contains fecal concretions, therefore whenever an apparently healthy appendix is felt to contain these there is sufficient reason for its removal.

In any case also where the patient specially requests that the appendix be removed, I think the surgeon should comply. The risk of the operation, properly done, is extremely small, and it is sometimes a great relief to a patient's mind to know that it has been removed, especially if there have been other cases of appendicitis among his family and friends.

REMOVAL OF THE APPENDIX WHEN OPERATIONS ARE PERFORMED IN ITS NEIGHBORHOOD THAT MIGHT GIVE RISE TO POST-OPERATIVE ADHESIONS.—In the case of men there is practically no risk that disease will arise in the appendix from altered conditions due to operations in its immediate neighborhood, but in women there is a possibility, although a remote one, that the appendix may become adherent to the fresh scar resulting from operations on the uterus or the right ovary. In my *Operative Gynecology*, published in 1895 (vol. 2, p. 523), I said: "The vermiform appendix may become involved in post-operative adhesions attaching it to the pedicle left in the pelvis, and causing severe pain in the right iliac fossa, with attacks simulating appendicitis. I operated on a patient of this kind, whose right ovary had been removed three years before by H. ROBB; I removed an inflamed left ovary and the uterus together with the appendix, which hung over into the pelvis and was firmly adherent at its end to the pedicle on the right side." Two other cases of this kind have come to my own personal knowledge, and I have collected six more reported in periodicals, or sent me in personal communications ("The Vermiform Appendix and its Diseases," p. 719.)

In speaking of two cases occurring in his experience G. R. FOWLER remarks: "This experience opens up a new field of inquiry as to the causes of painful stump and abdominal symptoms sometimes observed to follow operations upon the adnexa. Ever since the occurrence of my two cases, I have made it a rule to perform typical excision of the appendix when the latter is intraperitoneally situated, in every case in which the abdomen is opened for any operative structures within reach of this mischievous and useless organ."

Judging from the evidence just collected, it seems likely that adherence of the appendix to the scar of a previous operation stands in etiologic relation to a post-operative appendicitis much more frequently than has hitherto been supposed. Further data on the subject, therefore, are to be desired. These can only be obtained by operators for appendicitis, whether they are gynecologists or general surgeons, publishing all cases in which the appendix is found adherent to a scar at the site of a previous operation. The value of such statistics will, of course, be much enhanced if it can be shown by reference to a previous record that the appendix was normal at the time of the first operation; we have here also an additional reason for not neglecting the opportunity to examine the appendix whenever an occasion is afforded by abdominal section, as well as its removal when preternaturally long or lying within reach of a denuded surface in the peritoneum.

In order to avoid just such accidents as the adhesion of the appendix or of any other intact structure to the raw surface in the pedicle, CONDAMIN

of Lyons, following the distinguished LAROYENNE, has urged the careful covering in of all raw surfaces created by surgical operations in the peritoneal cavity. He dignifies this important principle by the name of "*peritonisation*" (*Lyon méd.*, 1894, p. 567). MCGUIRE, in the article referred to (*loc. cit.*), makes the important suggestion that whenever the right ovary is removed, the raw stump should be protected by covering it with peritoneum and burying it out of sight. H. KREUTZMAN of San Francisco, in discussing the treatment of the pedicle in ovariectomy and salpingo-oopho-



FIG. 186.—FINNEY'S CASE OF LONG APPENDIX ADHERENT BY ITS TIP TO SUSPENSORY LIGAMENT ATTACHING UTERUS TO ANTERIOR ABDOMINAL WALL.

Case of myomectomy and suspension by author; subsequent operation by Finney for the appendical complication. M. O. G., age forty-two. Jan., 1902. Recovery.

rectomy, recommends freeing a serous cuff from the vessels before ligating them, and after the ligation, delicately sewing together the serous surfaces so as to cover the stump completely (*Amer. Jour. Obst.*, 1896, p. 830). The same plan has also been advocated by WATKINS of Chicago. The necessity of protective measures is shown by the cases just cited, in which the adherence of the appendix to a raw surface after the removal of the right ovary was the exciting cause of an attack of appendicitis.

INCISIONS FOR REMOVAL OF THE APPENDIX.—The median incision is best in cases where the abdominal walls have been greatly

stretched by a pelvic tumor, or by repeated pregnancies, for then the right side of the incision is easily drawn over, and the right iliac fossa fully and easily explored (see Chap. XVII, Fig. 102). If the incision is not more than two and a half inches in length, it is difficult to reach the appendix, but this is easily accomplished through an incision three and a half to four inches long, extending not less than three-quarters or two-thirds of the way up to the umbilicus. The incision having been made, the right side is forcibly retracted toward the cæcum, which, at the same time, is drawn toward the opening. If the cæcum has a short mesentery, and the abdominal walls are rigid, it may be necessary to make another separate incision over the appendix in order to remove it. This is easily done by introducing the four fingers of the left hand into the abdomen and pushing up the abdominal wall, at the same time cutting down on muscles which can then be pulled apart after McBurney's method (see Chap. XVII, p. 284). The peritoneum is then opened, the appendix picked up by the hand inside the abdomen and pushed through the second small incision. To operate in this manner successfully it is always necessary to have the patient on a level table, as Trendelenburg's position causes the appendix to gravitate up toward the diaphragm, and it cannot be brought down without dangerous traction.

Semilunar Incision.—In cases where coincidence of appendicitis and pelvic disease is suspected before operation, or where the diagnosis is doubtful between right-sided pelvic inflammation or extra-uterine pregnancy and appendicitis, the best incision is in the semilunar line, directly over the right side of the pelvis and close to the root of the appendix.

Lateral Incision.—If, after opening the abdomen in the median line for pelvic disease, an abscess is found in association with the appendix, it is best to open the sac extra-peritoneally, using the median incision as a guide. The steps in the operation are as follows: The operator, if right-handed, steps to the left of the patient, and introduces four fingers of the left hand into the abdomen in such a manner as to grasp the abdominal wall between the thumb and fingers, the tips of the fingers resting upon the point of contact of the abscess with the abdominal wall. The incision is then rapidly made to the outside of this point through the skin and muscles and then cautiously prolonged into the abscess; if there is any uncertainty as to its exact location, the blunt end of a pair of artery forceps may be pushed into the tissues, after incising the muscles, without danger, care being always taken to avoid opening the peritoneal cavity by the fingers inside the abdomen, all contamination being thus limited to the hand used outside. After opening, evacuating, and drying out the abscess, and putting in the drain, the gloves can be changed, and the closure of the median incision proceeded with. If any intra-pelvic operation has to be performed, it had best be done before opening the abscess in the appendix.

REMOVAL OF THE APPENDIX.—If there is no suppuration, it is a matter of indifference whether the appendix or the pelvic disease is first treated,

Fig. 18.—The Upper 10 ft. shows lateral involvement of a fault in two-
 overlying A. is of the same size. Within and adjacent to Upper and
 Basin. Within the 10 ft. R. is shown in Upper and Lower Figures.
 A. is now a separate is. 10 ft. and the upper 10 ft. is at its base and passed as
 show. In the figure which the overlying is exposed and tied at B. Lastly, as
 exposed from the top of the fault and the lower is controlled at C.

FIG. 187.—THE UPPER FIGURE SHOWS EXTENSIVE INVOLVEMENT OF APPENDIX IN TUBO-OVARIAN ABSCESS OF THE RIGHT SIDE. WIDESPREAD ADHESIONS TO UTERUS AND PELVIC WALLS. THE METHOD OF REMOVAL IS SHOWN IN UPPER AND LOWER FIGURES.

A, the meso-appendix is tied off and the appendix detached at its base and grasped as shown in lower figure, when the ovarian vessels are exposed and tied at B. Lastly, as appendix, uterine tube, and ovary are lifted out of their bed of adhesions, the tube is excised from the uterine cornu and the vessels controlled at C.

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but, generally speaking, it is best to do the pelvic work first, and that on the appendix last. After removal of the appendix the opening into the cæcum should be closed as soon as possible. If there is suppuration in either the pelvis or the appendix, the clean operation should be done first. If both are infected, it is best to do the easier first, taking out the appendix at once by preference, as this must be removed, while the suppuration in the pelvis can be quickly drained by the vaginal vault.

When the Appendix is Adherent to the Ovary and Tube.—After widespread pelvic peritonitis, it may be without the presence of infective

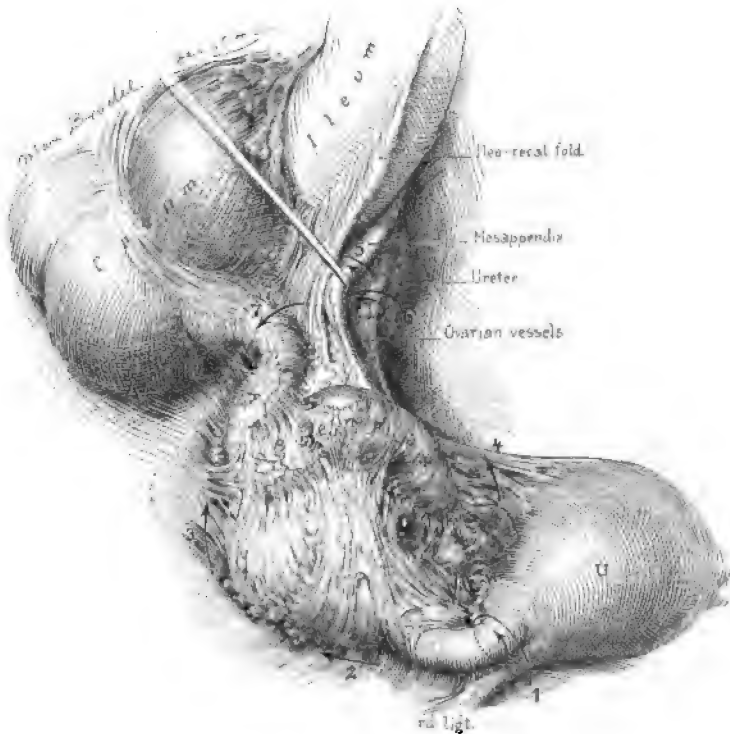


FIG. 188.—SHOWS THE METHOD OF REMOVING AN ADHERENT APPENDICO-TUBO-OVARIAN MASS IN REVERSE ORDER, FOLLOWING THE ARROWS, 1 TO 7.

organisms, the ovaries are often attached to the pelvic walls, while the sigmoid flexure, together with the appendix, is bound down or covered in by adhesions. If the adhesion is a light one, it may be simply detached, and the pelvic organs treated separately to the appendix, as their condition may require. If the adhesion is firm and intimate, one of two plans may be followed.

1. The base of the appendix is clamped first and the appendix severed; the ovarian vessels are then exposed and tied; and, lastly, the tube is excised from the uterine cornu and the vessels controlled (see Fig. 187).

2. The tube or the tubo-ovarian mass is first detached, beginning at the uterine cornu, and enucleation conducted in a direction the reverse of

that just described, according to the direction indicated by the arrows in the figure, the base of the appendix being finally clamped and severed (see Fig. 188).

When the Uterine Tube and the Ovary Coalesce with the Appendix to form an Abscess on the Pelvic Floor (see Fig. 189).—Under these circumstances



FIG. 189.—H. A. KELLY. TUBO-OVARIAN ABSCESS. PERI-APPENDICITIS.

Appendix adherent from root to tip, the distal portion following the dotted line lies upon the pelvic floor under tubo-ovarian abscess. Douglas' pouch is obliterated. E. L., colored, age eighteen. Autopsy, June 12, 1899.

extreme caution is necessary in order not to distribute the contents of the abscess over the peritoneal cavity. In the case of a large abscess with a patient in bad condition, I prefer to make simply a vaginal incision and secure good drainage, leaving the appendix to be removed, if possible, at a later date.

If the abscess is small and situated down in the pelvis, all the surrounding parts of the peritoneum must be walled off with gauze and completely

protected from contamination upon the escape of the pus. The appendix should then be detached from the cæcum, and its mesentery, together with the ovarian vessels, tied off. The uterine vessels should also be tied at the uterine cornu. As much of the pus as possible should be removed with an aspirator. Then the surgeon must make a cautious effort to peel out the whole mass, carefully working his fingers down underneath it in the posterior pelvis. Gauze or sponges should be freely used to take up any escaping fluid. If when the mass comes away it leaves any portion of its



FIG. 190.—H. A. KELLY. THE DISTAL PORTION OF THE APPENDIX ADHERENT TO THE BROAD LIGAMENT IN CASE OF LARGE MULTIOCLULAR OVARIAN CYST. H. F., age forty-eight. June 4, 1902. Recovery. (Natural size.)

infected wall clinging to the pelvic floor, the latter should be scraped with a knife-blade or a curette, and then freely touched with pure carbolic acid, followed by alcohol, after which the whole area should be covered with a loose handful of washed-out iodoform gauze, draining either at the abdominal wound or through a large opening at the back of the cervix into the vagina.

When the Appendix is Strongly Adherent to a Tumor of the Uterus or Ovary (see Fig. 190).—Under these circumstances the best plan of enucleation is to detach the appendix from the cæcum, and close the opening at once if possible. The tumor should then be removed with the appendix attached to it.

When Appendicitis is Complicated with Extra-uterine Pregnancy.—This condition offers no difficulties not dealt with in the preceding sections. The appendix should be removed either with the mass or separately, as the occasion requires (see Fig. 191).

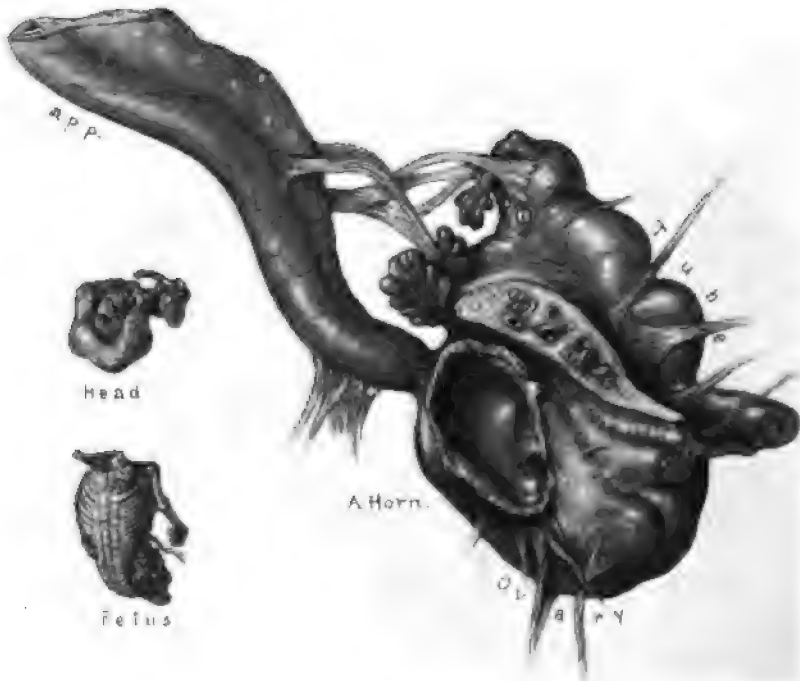


FIG. 191.—H. A. KELLY. APPENDIX ADHERENT TO UTERINE TUBE AND OVARY IN THE MIDST OF EXTENSIVE ADHESIONS.

The foetus shown on the left was found buried apparently in substance of ovary. A. W., age thirty. May 31, 1902. Recovery. (Natural size.)

RELATIONS OF APPENDICITIS TO PREGNANCY, LABOR, AND THE PUERPERIUM.

General Considerations.—The relation of appendicitis to pregnancy, labor, and the puerperium demands especial consideration for several important reasons. The extreme gravity of appendicitis complicating pregnancy and the puerperium, involving as it does the welfare of both mother and child, together with the difficulties in diagnosis and the risks to the child should operation be performed, combine to render this condition one of the most difficult for both the obstetrician and the surgeon. Although there are fairly numerous references in the literature to the occurrence of appendicitis during pregnancy, the cases are still too few to warrant any positive conclusions regarding the relative frequency of the complication; and as unfortunately only severe cases in general are reported, it is impossible to form a definite opinion concerning the prog-

nosis as regards either the mother or the child. In the early literature only a few isolated cases appeared. A case described by STUMPF in 1836, as one of rupture of the cæcum in a pregnant woman, was probably an early instance of perforative appendicitis; but the first case clearly recognized as such, and made the occasion of operation, was that of HANCOCK (*Lancet*, 1848, vol. 2, p. 381), who opened a perityphlitic abscess on the tenth day after a premature delivery. The patient stated that she had observed a swelling in the right side of the abdomen before her pregnancy, but previous to her confinement it had not caused her any uneasiness. Upon opening the abscess a quantity of turbid serum with shreds of fibrin and false membrane passed out. The patient improved immediately, but the wound did not heal, becoming inflamed and painful, until at the end of a fortnight two fecal concretions escaped, after which recovery soon followed (see Chap. I, p. 6). ABRAHAMS (*Amer. Jour. Obst.*, 1897, vol. 35) collected and analyzed 15 cases, which were all which had been reported at that time.

It is to be expected that appendicitis should frequently develop during pregnancy, because the early child-bearing age corresponds with the time when the disease is most frequent. The apparent rarity of the coexistence of the two conditions is probably to be explained by failure to recognize the mild forms of appendicitis, the symptoms doubtless being often attributed to disturbances due to the pregnancy; many of the more severe cases are mistaken for puerperal sepsis. H. N. VINEBURG (*New York Med. Jour.*, May 11, 1907) has collected from the literature 169 cases of acute appendicitis complicating pregnancy. According to statistics published by Treves and Vineberg, the latter taking all the cases in Mount Sinai Hospital, New York, for eight years, the proportion of acute appendicitis occurring in pregnancy is from one to two per cent. of all cases of appendicitis. It is not necessary to assume a direct etiologic relationship to account for the occurrence of appendicitis during pregnancy, and probably in the majority of cases the coincidence is purely accidental. FRÄNKEL (*Samml. klin. Vort.*, 1898, No. 229, p. 1335), opposing the view of Hlawacek (*Monat. f. Geb. u. Gyn.*, vol. 6, p. 327) and others, who hold that pregnancy is an important factor in the causation of appendicitis, considers that the appendix is subject to no different conditions in pregnancy than at other times. "An organ so variable in its size, its form and position, and normally so freely movable, can easily become adapted to the varying condition of pressure in the abdomen." It is probable, however, that in some instances pregnancy and labor have an indirect influence in exciting the inflammatory attack, especially when the appendix is already prepared by preëxisting disease. The obstinate constipation which is so common during the later months of pregnancy may readily provoke an active process in a latent appendicitis, while the excessive engorgement of the pelvic and hemorrhoidal veins very possibly affects the circulation in the appendix. LE GENDRE (*Rev. prat. d'obst. et de paed.*, 1897, No. 10, p. 200) refers to a case of Tuffier's in which three successive pregnancies

were accompanied with appendical attacks. Resection of the appendix, which contained a concretion, resulted in cure. LE GENDRE also calls attention to the fact that during pregnancy, as well as in the non-pregnant state, the menstrual molimen may cause relapses in a chronic appendicitis. He relates the case of a young woman who had suffered from repeated attacks of appendicitis, and in her first two pregnancies the appendical attacks, which had always been mild, occurred in greatly aggravated form. An attack during the second month of the second pregnancy was accompanied by symptoms of peritonitis. The illness gradually subsided, but

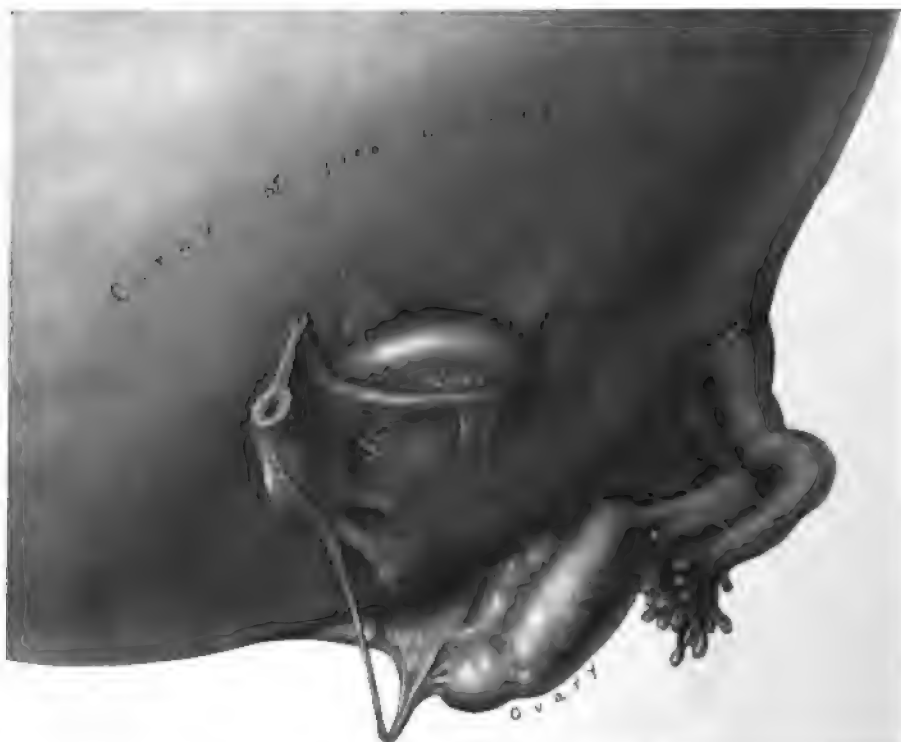


FIG. 192.—H. A. KELLY. APPENDIX ADHERENT TO THE PREGNANT RUDIMENTARY UTERINE HORN. SEEN FROM BEHIND. (Gyn. No. 5820, May, 1902.)

two days after the date for the menstrual period, an acute exacerbation took place. Recovery again followed, but it was decided to operate eight days before the time for the next period. The appendix, which was perforated at its base, was resected, together with a mass of inflammatory exudate and an enlarged gland. A smooth recovery followed, and the pregnancy continued its normal course.

When the appendix, as a result of antecedent inflammatory attacks, has become adherent to the uterus or to the ovary, tube, or broad ligament (see Fig. 192), the alteration in the anatomic relations and the traction upon the appendix consequent upon the pregnancy involve more or less

danger. The strong contractions of parturition and the sudden diminution in the size of the uterus when it has become empty have a more harmful effect than the gradual growth of the uterus during pregnancy. The most dangerous complication is met with when the uterus forms part of the wall of a peri-appendical abscess. With the expulsion of the foetus and sudden contraction of the uterus, rupture of the abscess, according to KÖNIG, is almost inevitable. A good example of the danger of this complication is described by MURET (*Zeit. f. Gyn.*, No. 94, p. 1359), where in the fifth or sixth month of pregnancy, a typical appendicitis developed, but soon subsided with a disappearance of all symptoms. The pregnancy went on to term, and a normal delivery followed, but two days later the patient died from peritonitis. Autopsy showed that the contraction of the uterus had caused rupture of an abscess.

MAYO ROBSON (*personal communication*, 1903) has operated on two cases of suppurative appendicitis developing almost immediately after accouchement. The first case was one of suppurative peritonitis arising from an appendix which perforated the day after delivery. Operation was performed on the third day, the appendix being removed, the pelvis and abdomen cleaned of pus, and lavage of the peritoneum performed. The patient recovered completely. In the second case, acute appendicitis, ending in abscess formation, developed a few days after confinement. At operation, performed ten days after delivery, it was found that the appendix, which was perforated and necrotic, had become fixed to the open end of the right tube, down which the pus was creeping. The tube and appendix were removed together and the patient made a good recovery.

THE EFFECT OF APPENDICITIS UPON PREGNANCY. — No statistical proof can be obtained from the limited number of observations reported regarding the relative frequency with which the death of the child results when pregnancy is complicated by appendicitis, yet all writers are agreed as to the extremely grave prognosis for it in severe cases. In mild attacks the normal course of the pregnancy is not disturbed. BOIJE (*Mitteilungen aus der gynäkologischen Klinik des Professor Otto Engstrom*, 1903, vol. 5) cites 18 cases from Engstrom's clinic, mostly of a mild type, in all of which the pregnancy proceeded normally. In other cases, even where a severe inflammation is cut short by operation, the pregnancy often proceeds normally. D. LEWIS (*Med. Recorder*, Chicago, 1901, p. 369) has successfully operated on five occasions during early pregnancy. In one instance a large abscess was incised and drained in the fourth month of pregnancy; and the labor proceeded without incident. C. STRICKLER (GLONIGER, *Amer. Med.*, Jan. 10, 1903) operated, in the fifth month of pregnancy, for acute appendicitis with obstruction due to adhesions. Recovery was uneventful, and a living child was born at term. T. K. HOLMES (*Amer. Jour. Surg. and Gyn.*, St. Louis, Feb., 1903) reported the case of a woman four months pregnant, operated on for gangrenous appendicitis with general peritonitis. Recovery followed, and the pregnancy proceeded to term, when a healthy child was delivered. Similar cases have been reported

by PENROSE, McCOSH and HAWKES, and many others. Generally, however, in severe cases abortion ensues. In some instances the foetus dies *in utero* from general toxæmia or septicæmia and is then expelled. Cases have been described in which the infection of the foetus and placenta was demonstrated bacteriologically. In a case of KÖNIG's a recently dead foetus was delivered spontaneously five days after incision of a peri-appendical abscess. The *bacillus coli communis* was found in pure culture in the organs of the foetus, in the placenta and in the large uterine veins. In most instances uterine contractions are primarily excited and a living child is delivered, which, however, often soon dies on account of non-viability or from infection. The uterine contractions may be provoked by direct inflammatory irritation or through general constitutional disturbance, especially high fever. In many cases premature delivery occurs early in the appendical attack, and in such a case a healthy child may be born, but when delivery occurs after the patient has become profoundly septic or when infection of the uterus has taken place, the prognosis for the child's life is less favorable.

With the act of parturition, whether it occurs at full term or prematurely, a dangerous complication is added. In the first place, as already explained, there is the almost inevitable rupture of adhesions and the probability of general distribution of the infection; and in the second place there is the danger of infection of the uterus with the virulent appendical organisms, constituting a true puerperal infection.

OPPENHEIMER relates the case of a woman who, in the seventh month of her pregnancy, presented symptoms of peritonitis. On the third day a living child was born. Three days later a large mass resembling a tumor of the kidney had developed, while necrotic masses were removed from the uterus. The patient died without operation, and the postmortem showed peritonitis resulting from perforative appendicitis and secondary infection of the placental site. A case of unusual interest described by A. MANTÉ (*Arch. gén. de. méd.*, 1903, No. 25, p. 1547) is as follows:

The patient, two days after delivery of a living child at term, began to have fever and fetid lochia. On admission on the ninth day, her abdomen was distended and she was evidently septic. Curettage and intra-uterine lavage were followed by a general improvement, but very soon the temperature again became elevated, the pulse small and rapid, and there were chills. A vaginal hysterectomy was then performed, and the uterus was found large and œdematous, but it only contained some fibrinous clots, the inner surface being a pale pink color. The patient died four days later, and at the autopsy the pelvis was found covered with greenish-white fetid pus, and the appendix, the tip of which was gangrenous and perforated, hung down into the pelvis and was in contact with the broad ligament. It was, however, absolutely free, and was doubtless the primary focus of the infection. The bacteria found in the appendix were the same as those obtained from the uterus.

While abortion is often followed by a rapidly fatal termination, this unfavorable result is not necessarily occasioned by the miscarriage, which, as pointed out by FRÄNKEL, is only one step in the development of the disease, and the severe general or local infection which induces the abortion also causes the death of the mother. KÖNIG believes that the presence of exceptionally dense adhesions between the intestines and pelvic

organs may interfere with the normal growth of the uterus and so predispose to abortion. In one case observed by this writer the patient had been the subject of several miscarriages, and at operation the adhesions found between the appendix, the intestinal coils, and the uterus were so dense that they could be severed only with the knife. These adhesions may also interfere to some extent with the normal involution of the uterus. In CRUTCHER's case (cited by Abrabams), after abortion complicating gangrenous appendicitis, it was necessary to curette and pack the uterus, which at autopsy was found to be normal except for the appendical adhesion. In MUNDE's and THOMASON's cases (*ibid.*) manual removal of the placenta was necessary.

Diagnosis.—The diagnosis of appendicitis complicating pregnancy may be exceedingly difficult. A typical attack, beginning with sudden, severe, abdominal pain, soon becoming localized in the right side and associated with localized tenderness, muscular rigidity, and constitutional disturbances, is generally recognized without difficulty; but if the pain and tenderness are not definitely localized, and the constitutional symptoms are slight, the pains, especially in a primipara, may be mistaken for a threatened miscarriage; and even if the pain is accompanied with vomiting, this is of little value in the diagnosis, because it may also accompany labor pains. Still greater confusion is found when the actual parturition is complicated with appendicitis, as the symptoms of the latter may be completely masked by the former or may be attributed to it. In a case related by HLAWACEK the patient had a chill a few hours after the onset of labor-like pains, and it was difficult to determine whether the chill was caused by labor or if there was an appendicitis. Palpation and percussion are often unsatisfactory in the later months of pregnancy on account of the distention of the abdomen by the pregnant uterus. It is, however, sometimes possible to detect an area of localized rigidity, and a tumor, very rarely the thickened appendix, may be clearly defined or separate from the uterus. Vineberg (*loc. cit.*) relates such a case in which he palpated the thickened appendix through a very thick abdominal wall in a woman six months pregnant. FRÄNKEL suggests, as an aid in differentiating a peri-appendical exudate from the uterus, that the patient be placed on her left side, when the uterus sinks in that direction, and the inflammatory mass is more easily palpated. The presence of a severe infection is readily recognized by the characteristic constitutional disturbances, and its source may usually be determined if a careful description of the onset of the attack is obtained, and especially if there is found to be a history of antecedent appendicitis. Great difficulty in arriving at a diagnosis is also experienced when the appendicitis develops a few days after delivery, in which case the symptoms may simulate puerperal infection, or, indeed, may be accompanied with a secondary infection of the uterus, as in the case of MANTÉ, already cited.

In the early months of pregnancy the differential diagnosis between uterine pregnancy complicated with appendicitis and ruptured ectopic

gestation may be very perplexing. The distinguishing features have been described on a previous page. The differential diagnosis of appendicitis from other conditions accompanying pregnancy, especially pyelitis and other renal diseases, is based upon the same characteristic features as it is in the non-pregnant state (see Chap. X).

Treatment.—The operative treatment of appendicitis in pregnancy and in the puerperium is a matter of great importance, as, owing to the constant changes in the anatomic relations of the viscera, the severer forms of the disease, in which an abscess is evolved, are less liable to be checked or limited in their extent. Furthermore, the danger always involves two lives and the happiness of an entire family.

For these reasons, and because of the well-recognized severity of any attack of appendicitis associated with suppuration during pregnancy, prompt interference is demanded as soon as a diagnosis is clearly made. The operator, in urging upon the patient a prompt recourse to surgical treatment, however, must be guarded in his statement, for numerous cases are recorded in which the patient has refused the operation, and yet has recovered, gone on to term, and been delivered of a living child. HERRGOTT has said that for women in the child-bearing period of life the operation for a recurring appendicitis is more than usually urgent, on account of the dangers they incur should an attack take place during a pregnancy. In these cases, therefore, the interval operation is in a special sense prophylactic, saving both mother and child a risk which has often been reckoned as having a mortality as high as 50 per cent.

The earlier in the course of pregnancy the operation is done, and the earlier in the course of the disease, the better for the patient. In these cases the usually conservative surgeons of Germany take, as a rule, the same radical stand which is taken by their American and French colleagues. FRÄNKEL, for instance, says that "in case of a relapse in a pregnancy, the operation is to be recommended even while the clinical symptoms are of a mild nature, especially in the earlier months of the pregnancy."

In performing the operation it is best to use a McBurney's incision, enlarging it, if necessary, by dividing the aponeurotic and the muscular fibres in order to secure the freest possible drainage when there is suppuration. It is important to handle the tissues as little as possible in the course of the operation, and, above all, to avoid exposure and all manipulations of, or traction upon, the uterus. The intestines should be well packed off, and the whole procedure should be conducted under the assumption that any infection is far more likely to spread throughout the peritoneum than under ordinary circumstances.

If the operation is a timely one, and has been conducted with gentleness and without trauma, undue prolongation, or shock, the pregnancy may advance to term without interruption. If a widespread peritonitis is found associated with pregnancy, the hopes for the patient's life are but small. In such cases the most liberal drainage should be used; if tympany is excessive, a small intestinal fistula should be made, and the pregnancy

terminated by emptying the uterus *per vaginam*. It is of the utmost importance that the pelvis should also be perfectly drained, preferably in an upward direction on account of the risk of infecting the uterus.

In the case of an active appendicitis occurring at the end of pregnancy the pregnancy may be terminated by an *accouchement forcé*, as recommended and practised by MARX, to save the life of the child, and the abdomen then opened in order to treat the appendicitis. The risk of the two operations, however, associated with the likelihood of distributing an infection by the contractions and changing volume of the uterus, is so great that this plan should be adopted only in exceptional cases. When there is reason to believe that pus is present or that an abscess has formed, it is wiser to open and drain simply and let the uterus alone. Such cases can go on undisturbed to term, with apparently less risk than if the uterus is emptied at once in order to anticipate the slow abortion which often occurs, but upon this point further data are wanting.

While appendicitis occurring in the course of pregnancy is dangerous, it is still more dangerous, and prompt interference is even more urgent, in appendicitis arising in the early puerperium. In some instances these cases owe their origin to the recent violent changes in the anatomic relations of the lower abdominal viscera, which break up adhesions, and where the uterus has formed part of the protecting wall of an abscess, rupture the sac and distribute its contents through the peritoneum. This last group of cases is well-nigh hopeless; nevertheless a prompt operation should be performed and liberal drainage instituted. If the appendicitis comes on during labor, it is best to terminate labor first, and then make sure of the diagnosis and operate on the appendicitis (LABHARDT).

CHAPTER XXII.

NEOPLASMS.

Introductory.—The number of cases recorded of primary tumors in the vermiform appendix is small, but during the past few years, since the operative treatment of right iliac disease and careful routine, laboratory examination of the removed organ has become general, it has been found that they are by no means so rare as formerly supposed. The few instances described in the older literature were supposed to belong to the *carcinomata*, but owing to the lack of microscopic examinations and the meagre description of the gross appearance, there is just doubt in many of these cases as to the true nature of the growth. Since 1898 a considerable number of cases of malignant neoplasms limited to the appendix have been carefully described, while secondary involvement of the organ is comparatively common. Benign tumors, however, are still (it would appear) extremely rare. This may be partly owing to the fact that on account of their small size and clinical insignificance they have not been considered worthy of special attention. The tumors originating in the appendix may be classified as follows:

Benign Tumors:	{ Polyp. Myoma. Fibroma. Myxoma. Lipoma.	Malignant Tumors:	{ Carcinoma. Sarcoma.
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In addition to these it may be mentioned that LAFFORGUE (*Thèse de Paris*) mentions two instances of *lymphadenomata* of the appendix; and in a case of Hodgkin's disease, furnished me by L. HEKTOEN of Chicago, the appendix was enormously enlarged, forming a sausage-shaped tumor 12 by 2.5 cm. Its walls were uniformly thickened, the canal almost obliterated, and the neighboring portion of the cæcum contained a large lymphomatous mass which projected into the bowel. Microscopic examination revealed the usual hyperplasia of lymphoid elements.

BENIGN TUMORS.

Polypi.—Unlike other portions of the intestinal tract, the appendix is but rarely the seat of these formations, and so far as I can discover no cases have been mentioned in the literature. I have observed four instances, one of which occurred in my own practice. In subacute inflammation the mucous membrane lining the appendix is often thrown up into polyp-like folds, which may be so exuberant as to form a distinct-

tumor, causing considerable distention of the canal, and at first sight even suggesting a new-growth. Inspection of sections made through the tissues, however, shows that the outgrowths are composed of sub-mucosa and mucosa, and differ from true tumors in that the tissues preserve their normal relations to one another. Histologically, there is merely a more or less severe inflammatory process characterized by a marked increase in the number and size of the blood-vessels, associated with hyperplasia of stroma cells and leucocytic infiltration. A good example of this condition is illustrated in Fig. 193.



FIG. 193.—H. A. KELLY. POLYPOID MASS (a) PROJECTING FROM THE CÆCAL END OF THE APPENDIX. (Gyn. No. 7272.)

a', Cut surface of polyp; b, mucosa; c, submucosa; d, musculature.

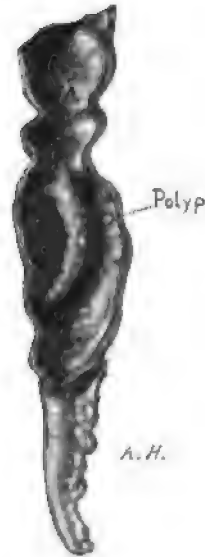


FIG. 194.—OVIATT'S CASE OF POLYP IN THE APPENDIX, REMOVED WITH THE APPENDIX SIX WEEKS AFTER AN ATTACK OF APPENDICITIS.

J. H. H., Gyn. No. 7272. The patient, a woman thirty-two years old, was operated on for pelvic inflammatory disease. There was a tubo-ovarian abscess on the left side, and on the right the appendix was adherent to the inflamed tube and ovary. There was no history of appendicitis, the patient's only complaint being of a profuse vaginal discharge. The appendix was short, with its somewhat bulbous extremity buried in adhesions. Its base was densely attached to an area of thickened cæcum extending about 2 cm. on all sides. The bowel was extensively opened by amputation of the appendix with the entire thickened area of cæcum. Projecting from the orifice of the appendix was the curious polypoid mass shown in the figure. The microscope showed merely a subacute inflammation.

Single sessile or pedunculated polypi are also the product of an inflammatory process. They may be composed entirely of mucous membrane, but more often they have a stem consisting of the submucosa. In the specimens that I have seen, the glands of Lieberkühn, the stroma, and the lymph-nodes were well preserved and, excepting for slight congestion of the blood-vessels and leucocytic infiltration, the tissue was normal. The specimen shown in Fig. 194 was removed at operation by C. W. OVIATT

of Oshkosh, Wis. The patient, a boy of twelve, had suffered from a severe attack of appendicitis six weeks previously, and at the time of his admission to a hospital a tender mass was detected in the region of the appendix. On opening the abdomen a perforation was found near the base of the appendix and a moderate-sized fecal concretion lay free in an abscess cavity. The middle portion of the appendix was abruptly distended, and upon being opened after removal, proved to contain a small pedunculated tumor. Under the microscope this was found to consist of the normal

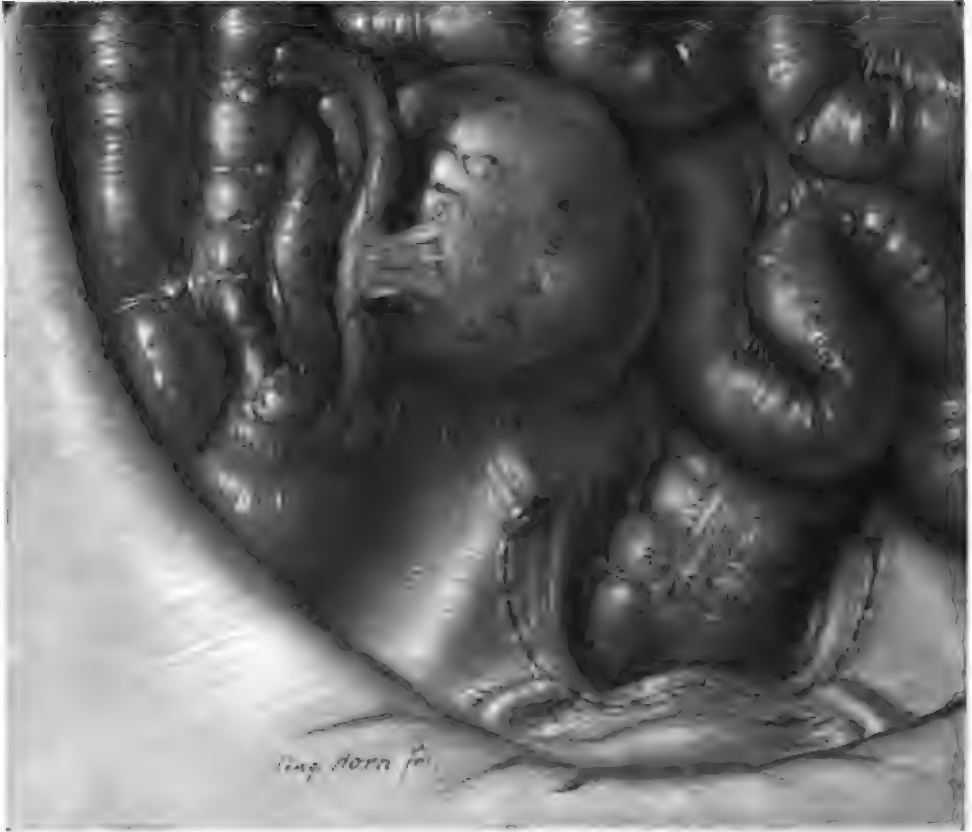


FIG. 195.—T. S. CULLEN'S CASE OF PARASITIC MYOMA ADHERENT TO THE APPENDIX. (Path. No. 5754.)

elements of the mucous membrane. The specimen shown in Chap. V, Fig. 50, was removed at operation, by I. R. TRIMBLE, for acute appendicitis, and shows practically the same structure. A similar specimen was sent to J. C. BLOODGOOD by CARSON of St. Louis.

Myxoma.—The only instance of myxoma in the vermiform appendix that I find recorded in the literature is a case shown by CHURTON to the Medical and Surgical Society of Leeds (H. ABOULKER, *Thèse de Paris*, 1899). The patient, a young woman twenty-two years old, admitted with a history of two attacks of appendicitis, complained of being unable

to work on account of constant pain in the cæcal region. The appendix was removed by MAYO ROBSON. It presented a thickened extremity, and on being opened showed a sessile, transparent tumor, the size of a small haricot-bean, obstructing the lumen to within 3 cm. of the tip, which was slightly distended with mucus. There were no adhesions nor other signs of peri-appendicitis. An instance has also come under my own observation in which a myxomatous tumor was attached to the peritoneal surface of the appendix. The patient was a young colored girl, upon whom an exploratory laparotomy was performed for the purpose of discovering the cause of severe abdominal pains of which she complained. Nothing was found except a few adhesions between the liver and the anterior abdominal wall and, attached to the middle of the appendix, which was hypertrophied and obliterated but free, was a small, firm, transparent nodule, 1.5 by 1 by 0.8 cm. in size, which, on microscopic examination, proved to be a pure myxoma.

Myoma and Fibroma.—Three cases of myoma of the appendix have been recorded, two by A. O. J. KELLY and one by HAYEM. In the two cases described by Kelly the tumors were small, about 5 mm. in diameter, and were situated in the muscular coat. They were designated fibromyomata. In one case (Kelly) there was a considerable amount of calcareous deposit. In all three cases there was an associated chronic inflammation of the appendix, characterized by hypertrophy of its walls and arteriosclerosis. The case of probable parasitic myoma shown in Fig. 195 was removed from a woman who was operated on for uterine myoma. The iliac tumor, which had no anatomic connection with the uterine growth, was situated behind a peritoneal fold and received its blood-supply by branches from the superior mesenteric vessels. A similar case is described by SONNENBURG, but in this instance the appendix was not found.

Fibroma limited to the appendix has not been reported, but in this connection a remarkable tumor of the kind, which chiefly involved the appendix and had evidently originated in the mesentery of the appendico-cæcal region, was observed in the gynecological department of the Johns Hopkins Hospital.

MALIGNANT TUMORS.

Carcinoma.—From autopsy statistics we are led to believe that primary carcinoma of the appendix is very rare; for instance, Maydl and Nothnagel (*Spec. Path. u. Therap.*, 1898, vol. 17, p. 638) found among 40,738 autopsies made at the Vienna General Hospital during the twenty-two years from 1870 to 1892 only two cases of carcinoma of the appendix out of 343 instances of cancer of the digestive tract. Our knowledge of the condition is derived at present from the findings of the operating-room rather than the dead-house, although, as shown recently by Letulle (*Rev. de gynéc. et de chir. abd.*, 1907, vol. 40, p. 875), cancer of the appendix in a not advanced stage is to be found not infrequently at post-mortems if search is made for it, he having found 7 cases in the course of 800 autopsies. The older writers were of opinion that all neoplasms of

the appendix were secondary, and it was not until MERLING in 1838 (*Jour. de l'Expérience*, 1838) described a case of primary carcinoma that it began to be referred to in literature. The second case was reported by PRUS in 1865 (CRONZET, *Thèse de Paris*), and two years later ROKITANSKY described 4 cases of colloid tumor of the appendix (*Med. Jahrb.*, 1867, vol. 13, p. 179).

The cases of MAYDL, of LEICHTENSTERN (*Ziemssen's Handbuch*, 1876), and of LEMAN were mentioned in autopsy statistics without further comment; in other cases the description left some doubt as to the nature of the disease, and in some, again, as to the organ in which the growth originated. The majority of the early cases described cannot therefore be accepted as genuine instances of primary carcinoma of the appendix. The first authentic case of primary carcinoma of the appendix was reported in 1882 by BEYER (*Berl. klin. Wochenschr.*, 1882, vol. 19, p. 617). There was not another undoubted case of malignant disease of the appendix until GLAZEBROOK in 1895 brought forward a case of "endothelial sarcoma" (*Virg. Med. Month.*, 1895, vol. 22, p. 221).

During the past twelve years the number of cases reported has been greatly augmented, and in most instances the tumors have been carefully described. A. W. ELTING in 1903 reported to the New York State Medical Society 40 cases of carcinoma of the appendix collected from the literature, 22 of which were undoubtedly primary (*Trans. N. Y. Med. Soc.*, 1903, p. 324). In February, 1906, H. D. ROLLESTON and L. JONES (*Amer. Jour. Med. Sci.*, June, 1906) had collected from the literature 37 cases of primary carcinoma of the appendix, including the three cases reported in my monograph. On account of the absence of accuracy in reporting and the lack of definite references, it seems wiser not to accept these as *bona fide* cases, but to use Elting's collection of twenty-two cases as a basis on which to construct the superstructure of our present-day knowledge. The subject of primary carcinoma of the appendix has recently received the most exhaustive treatment at the hands of J. H. ZAAIJER of Amsterdam (*Beiträge z. klin. Chir.*, 1907, vol. 54, p. 239). It seems proper to quote largely from his article, to cite his cases and to add to them the additional instances found in the literature in order to bring the subject up to the year 1908. Elting's 22 cases were reported by the following persons: Beyer, Stimson, Wright, Mossé et Daunic, Hurdon, Giscard, Rolleston, Goffe, Weir, and Jessup, one case each; Elting, McBurney, A. O. J. Kelly, and Harte and Willson, two cases each; Letulle and Weinburg, four cases each. Zaaier adds 38 cases by the following authors, the clinical and anatomical proof that the disease was carcinoma and primary in the appendix being given in each case: De Bovis, Léjars, Norris, Burnam, Hessberg, Cullingworth and Cornet, Jones and Simmons, Weinberg, Neri, Driessen, Battle, Meyerstein, Landau, Hulst, Tendeloo, and Sormani, one each; Kaufmann, two cases; Kelly and Hurdon, Baldauf, Sudzuki, and Moschowitz, three each; Letulle and Zaaier, four each. To these I will add 20 cases by the following authors: R. Weil (*Proc. N. Y. Path.*

Soc., 1905-06, N. S. vol. 5, p. 128), D. Grunbaum (*Berl. klin. Wochenschr.*, 1907, vol. 44, p. 894), W. McA. Eccles (*Amer. Jour. Med. Sci.*, 1906, N. S. vol. 131, p. 966), N. R. Mason and L. J. Rhea (*Bost. Med. and Surg. Jour.*, 1907, vol. 156, p. 44), Pauchet (cited by Claude, *Thèse de Paris*, 1903), Jalaguier (cited by Letulle, *Rev. de gynéc. et de chir. abd.*, 1907, vol. 11, p. 875), F. Villar (*Gaz. hebdom. des sci. méd.*, Bordeaux, Jan. 3, 1904), A. S. Warthin (*Phys. and Surg.*, Detroit, 1906, vol. 28, p. 544), J. J. Coons (*Surg. Gyn. and Obst.*, July, 1908), Nélaton (*Bull. et mém. Soc. chir. de Paris*, 1907, N. S. vol. 33, p. 247); two each by F. S. Mandelbaum (*Proc. N. Y. Path. Soc.*, 1905-06, N. S. vol. 5, p. 150), P. Lucène (*Bull. et mém. Soc. de chir. de Paris*, 1907, N. S. vol. 33, p. 222), and C. E. Brandts (*Münch. med. Wochenschr.*, 1907, vol. 54, p. 1780); and three by O. Nordmann (*Arch. f. klin. Chir.*, Berl., 1906, vol. 78, p. 293). To these may be added an unpublished case by Day and Rhea to be found below. These cases have not been cited in detail because of lack of space. In every instance the diagnosis appeared to be well established and there seemed to be no doubt that the disease was primary in the appendix; all cases where the cæcum or surrounding structures were involved and all cases of metastases having been excluded, as well as those in which the description was faulty.

We have to do with 80 cases, 58 of which have come to light since Elting read his paper in January, 1903; therefore it would appear that primary carcinoma of the appendix is not such an uncommon disease as has hitherto been supposed. Zaaier is inclined to agree with Baldauf that primary carcinoma of the appendix represents about one per cent. of all cases of appendicitis, seven authors—namely, Elting, Moschowitz, Neri, H. A. Kelly, Baldauf, Sudzuki, and Zaaier—having met with 18 cases out of 2322 observations in their own experiences where all the pathological specimens were examined systematically.

Through the courtesy of the Pathological Department of the Boston City Hospital, I am able to report the case of primary scirrhus carcinoma of the appendix referred to above. It is to be published by Dr. Hilbert F. Day and Dr. Lawrence J. Rhea (*Bost. City Hosp. Serv.*, 1907, Third Surgical Service, Dr. H. A. Lothrop).

The patient was a little girl nine years old. She was in good health until a month previous to entrance except for the usual children's diseases. A month before she was seen, she began to complain of general abdominal pain, not definitely localized and causing no particular disability. Two days before admission she had pain in the epigastrium, which next day was referred to the right lower quadrant of the abdomen. There was some tenderness in the locality, accompanied by a rise of temperature and pulse. She was admitted with a diagnosis of acute appendicitis. Examination showed some pallor and emaciation; her pulse and temperature were elevated, and she complained of considerable pain over the region of the appendix, where a mass the size of a hen's egg could be made out, which was supposed to be an abscess of the appendix. Operation showed acute appendicitis with peri-appendical abscess, walled off from the general abdominal cavity. The appendix showed a spot of gangrene with a perforation. The wound was closed except for a small drainage opening. Recovery was good. Pathological examination of the appendix showed that it measured 6 cm. in length. The distal 3 cm. was friable and covered with a greenish exudate. A small perforation was situated 2.5 cm. from the tip. The

lumen was patent and somewhat dilated except the last 8 mm. at the tip. The walls of the cæcal half of the appendix were normal, but through the outer half there were various stages of inflammation up to necrosis. Microscopic examination showed both acute and chronic inflammation in the distal half, while sections through the distal end showed irregular masses of epithelial cells lying within the dense connective tissue. These epithelial cells were arranged in irregular alveoli, and many of them showed swellings and vacuolations. They were mostly spheroidal or polyhedral in shape, with deep-staining nuclei. No mitotic figures. This group of cells lay in dense connective tissue and involved all the coats of the appendix. The diagnosis was acute gangrenous appendicitis and scirrhus carcinoma of the vermiform appendix.

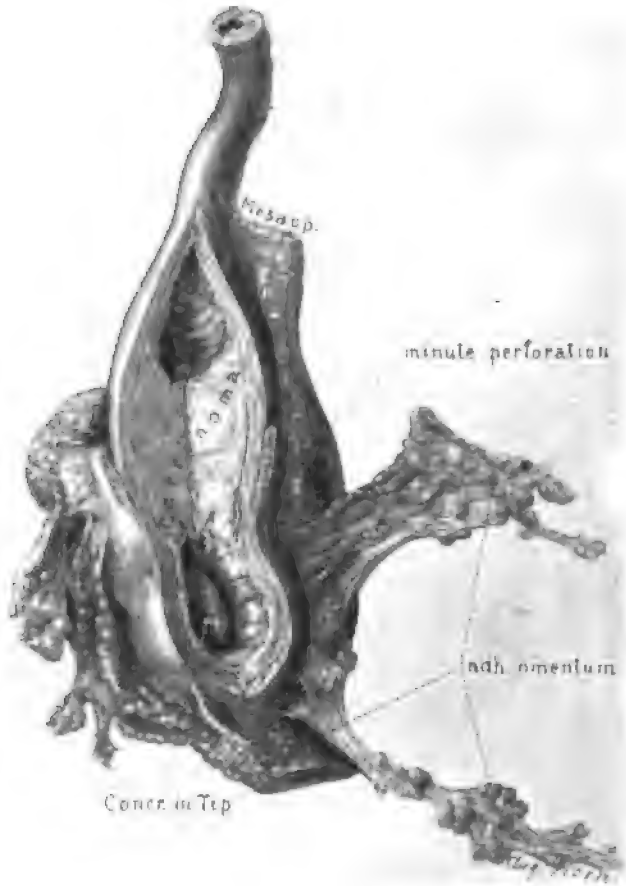


FIG. 196.—W. S. HALSTED'S CASE OF CARCINOMA OF THE APPENDIX CAUSING ACUTE PERFORATED APPENDICITIS. (Surg. Path. No. 2599.)

PATHOLOGY OF CARCINOMA.—The tumor is generally situated near the tip of the appendix; in a few cases it has been found near the cæcal end. Two characteristic examples of carcinoma limited to the tip, sent me by C. McBurney, are shown in Figs. 197 and 198. Attention has been directed to the fact that in some instances of carcinoma of the cæcum

involving the appendix, the original focus may have been in the latter. In a case reported by DRAPER (*Bost. Med. and Surg. Jour.*, 1899, vol. 38, p. 180), in one of REYLING's, in one of ELTING's cases and in many other of those reported, it cannot be definitely determined whether the growth originated in the appendix or in the cæcum. In a case of carcinoma of the cæcum involving the appendix observed in Prof. HALSTED's clinic, the possibility of an appendical origin was considered.

Gross Appearance.—The size of the tumor varies from 5 to 12 mm. In GLAZEBROOK's case, described as endothelioma, the tumor



FIG. 197.—McBURNIE'S CASE OF PRIMARY CARCINOMA LIMITED TO THE TIP OF THE APPENDIX, THE REMAINDER OF WHICH IS NORMAL.



FIG. 198.—McBURNIE'S CASE OF PRIMARY CARCINOMA OF THE TIP OF THE APPENDIX.

There is a slight constriction proximal to the growth and the mucosa is somewhat swollen and hyperæmic. (Museum, N. Y., No. 2020.)

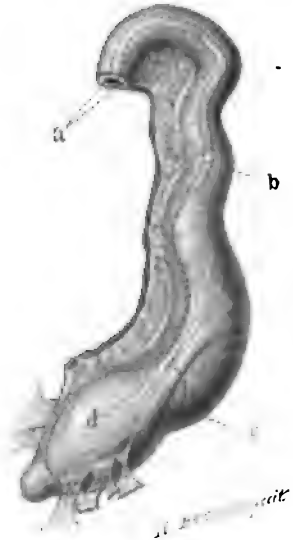


FIG. 199.—H. A. KELLY. CARCINOMA OF THE APPENDIX.

The proximal end of the appendix (a) is normal, from b to c there is a distinct thickening, and beyond this area the lumen is dilated (d). (Spec. No. 2854.)

was the size of a pigeon's egg, in BERGER's the size of a walnut, while in a case reported by HARTE and WILLSON (*Med. News*, 1902) the growth was diffuse, and with the naked eye could not be distinguished from chronic obliterative appendicitis. As a rule, the tumor appeared as a firm, white nodule, fairly definitely circumscribed. Such a growth upon superficial examination may readily be mistaken for a simple fibroma, but careful inspection of a section reveals a less coarsely fibrillated structure and the presence of homogeneous, yellowish-gray areas studding the fibrous tissue. Furthermore, while the tumor appears to be generally circumscribed, it cannot be shelled out, and in places the margin gradually merges into the surrounding tissue. In the case of HARTE and WILLSON cited above,

there was no distinct tumor, but a general invasion of almost the entire appendix was visible under the microscope. In ROLLESTON'S case the mass presented a caseous appearance and tuberculosis was suspected.

Histologic Examination.—Only a few of the cases of carcinoma of the appendix conform to the usual type of glandular intestinal carcinomata. In the case reported by BERGER the tumor is described as consisting of proliferating Lieberkühn's glands (*Arch. f. Chir.*, vol. 18,

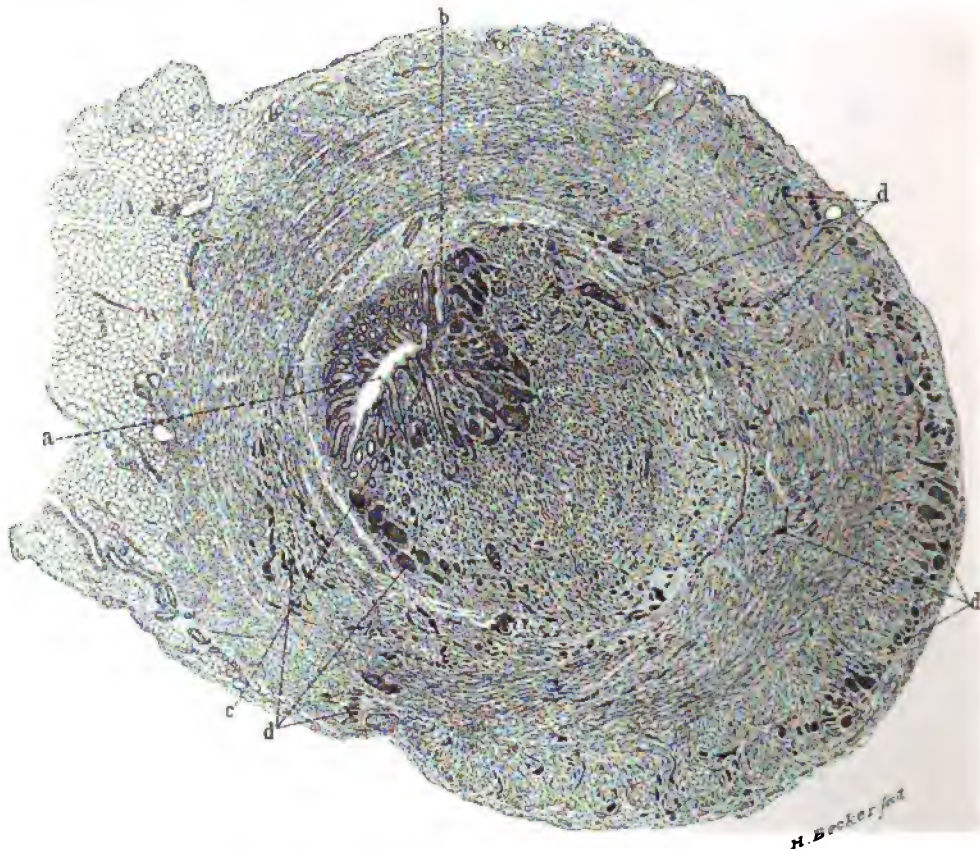


FIG. 200.—SECTION FROM THE CASE OF CARCINOMA OF THE APPENDIX SHOWN IN FIG. 197.

The lumen (a) is almost obliterated by the encroachment of the tumor, which has apparently originated in the mucosa at the point between b and c. Cell nests (d) have penetrated all the layers.

p. 306). The majority of cases belong to a less usual type, consisting of round, oval, or irregular alveoli filled with small polymorphous cells, having a scanty protoplasm and sharply stained vesicular nuclei. Mitotic figures are seldom abundant and may be scarce. In but few places is there any evidence of a glandular formation. Generally, however, where the growth is traced to its origin in the mucous membrane, a lumen may be detected in one or two of the alveoli, and it is usually possible to trace a direct histogenetic relationship between the tumor and the crypts of Lieberkühn. The tumors show a distinct local invasive tendency,

penetrating the submucous and muscular coats with but few exceptions. In the case reported by NORRIS (*Univ. of Penn. Med. Bull.*, 1903, p. 334) the cell nests extended into the mesappendix. Out of 11 cases examined under the microscope by Dr. E. HURDON, including a case reported by her in the *Johns Hopkins Hospital Bull.*, 1900 (see Figs. 199, 200, and 201), 9 were of this variety, one a distinctly glandular type, and one a colloid carcinoma. These tumors in their histologic and their gross appearance are very similar to a group of multiple carcinomata of the small intestine found by C. BUNTING and to be reported hereafter (*Johns Hopkins Hospital Bull.*). From a study of one case observed and the few recorded

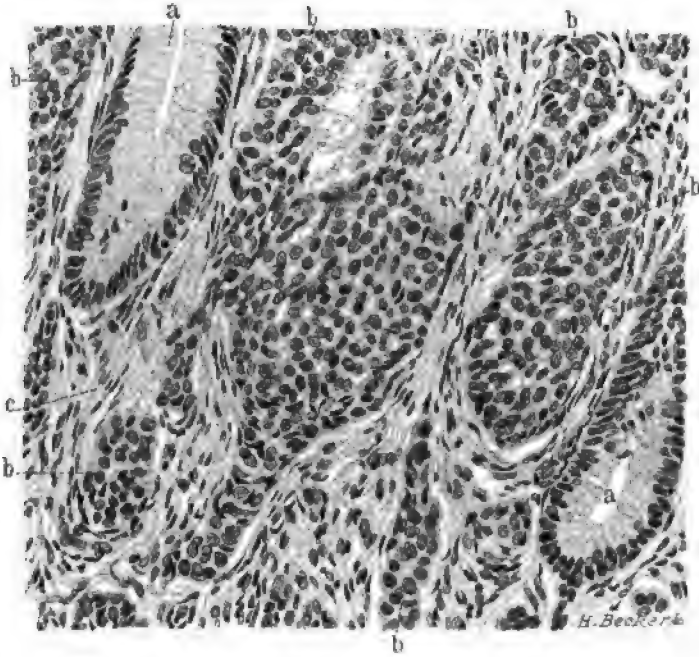


FIG. 201.—A SMALL AREA FROM FIG. 200. ENLARGED 350 TIMES.

Normal crypts of Lieberkühn are seen at *a*, and nests of tumor cells at *b*; *c* indicates the stroma.

in the literature, this writer arrives at the conclusion that such tumors have a generally benign tendency, and bear a striking resemblance to the basal-cell carcinomata of the skin described by KROMPECHER. Unlike the tumors observed in the appendix, these tumors of the ileum were all found in persons of advanced years. A less benign tendency is noticeable in the appendical tumors, notwithstanding the fact that many were discovered accidentally at operation or at autopsy. In several instances there was extensive invasion of the surrounding structures. In others perforation of the appendix with consequent peritonitis had occurred, the rupture showing a definite relation to the new-growth. In still other instances there was fairly definite evidence that a carcinoma of the cæcum was secondary to the appendical growth. DE RUYTER (*Arch. f. klin. Chir.*,

vol. 69, p. 281) relates a case in which at autopsy a carcinoma was found to have developed in the stump of the appendix, which had been removed six years previously. Involvement of the regional lymph glands occurs apparently late in the disease, and was observed in only 2 cases.



FIG. 202.—COLLOID CARCINOMA OF THE APPENDIX, DISCOVERED AT AUTOPSY. (From A. Elting, Albany, N. Y.)

According to ZAAIJER's analysis of 57 cases, cylindrical-celled carcinoma occurred in 31.3 per cent., transitional forms in 15.7 per cent., round and polymorphic celled carcinoma in 49 per cent., and colloid carcinoma in about 4 per cent. These figures are to be compared with those of KAPPERS and VAN ROOYEN (*Zeitschr. f. Krebsforsch.*, 1906, vol. 4, Hft. 2) for cancer of the alimentary tract. The latter investigators found adenocarcinoma

in 56 per cent., mixed forms in 13.2 per cent., polymorphic celled diffuse carcinoma in 20.7 per cent., and colloid carcinoma in 9.5 per cent. For the bowel alone adenocarcinoma occurred in 72.7 per cent., so that the preponderance of cylindrical celled carcinoma is greater in the cancers

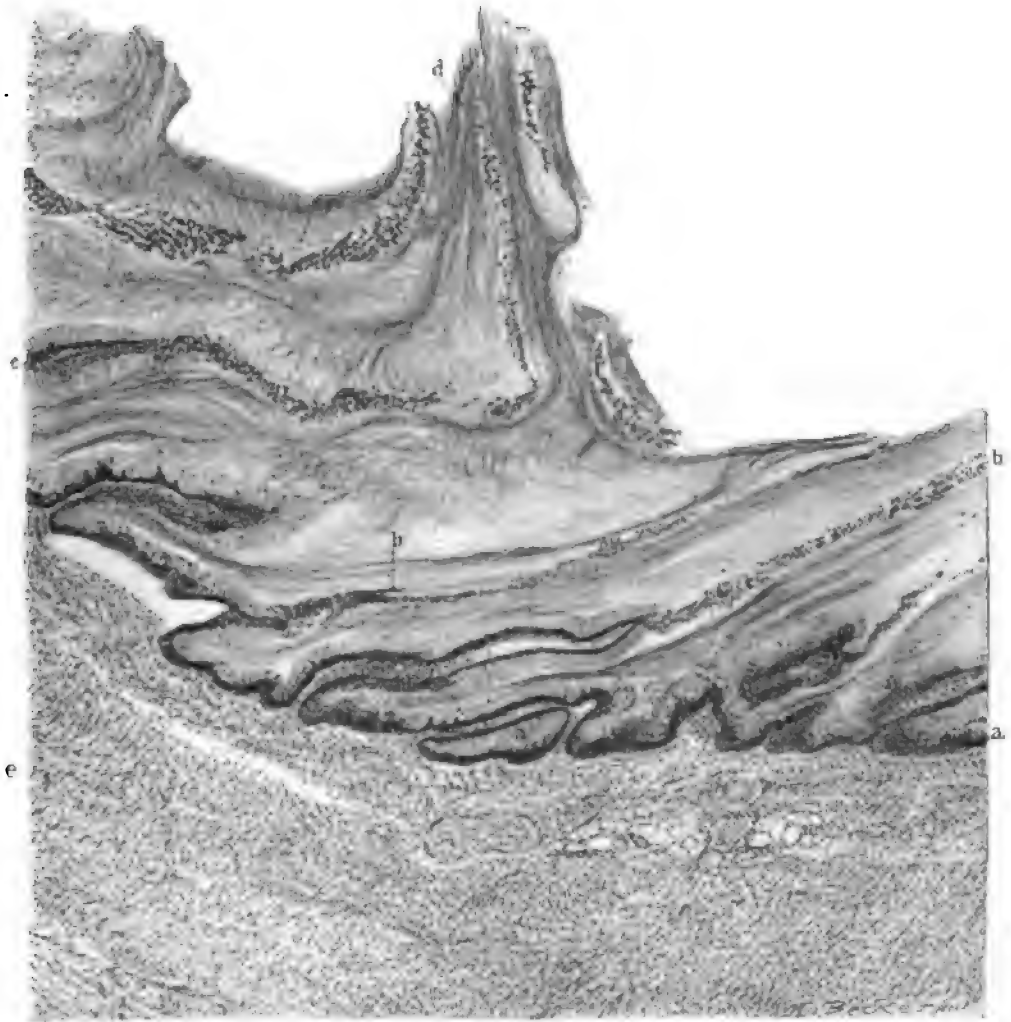


FIG. 203.—SECTION FROM PRECEDING CASE OF COLLOID CARCINOMA.

a. Gland lined with cylindrical epithelium; *b.* epithelial cells, colloid degeneration; *c.* beginning degeneration of the cells; *d.* colloid material; *e.* submucosa.

of the bowel than in those of the appendix. Cases of "endothelioma" have been reported, one by GLAZEBROOK and another by A. O. J. KELLY.

ETIOLOGY OF CARCINOMA.—The frequent occurrence of chronic obliterative appendicitis in association with the carcinoma, and the definite relation which the new-growth sometimes bears to stenosed areas, afford

strong presumption of an etiologic relationship. In cases described by LETULLE and WEINBURG and by HARTE and WILLSON, as well as in one of ELTING's cases, there was distinct evidence of chronic obliterating inflammation. SUDZUKI (cited by Zaaijer) examined microscopically 300 obliterated appendices and found three cases of carcinoma among them. In 2 cases described by Letulle and Weinburg the tumor was situated at a point of stenosis, the result of several attacks of appendicitis. It has been frequently pointed out that malignant growths are especially prone to develop in atrophying or vestigial structures. The appendix therefore would seem to afford a particularly favorable site for them.

Mechanical irritation appears to play an unimportant rôle in the development of tumors in the appendix. Considering the frequent occurrence of carcinoma following stones in the gall-bladder and bile-ducts, it is somewhat surprising how few cases occur similarly in the appendix. This may, perhaps, be explained by the fact that hard concretions, such as are formed in the gall-bladder and its ducts, and are liable to injure the tissues, are less common in the appendix, most of the so-called concretions, consisting of inspissated fecal material, being of rather soft consistency. Enteroliths and hard bodies, owing to the structure of the appendix and the abundant bacterial life, often determine a perforative appendicitis; therefore the appendix is not subjected to the long-continued mechanical irritation which obtains in the case of the calculi in the gall-bladder. In 3 cases, two reported by HARTE and WILLSON and one by myself, concretions were found, but showed no demonstrable relation to the growth. In a case occurring in the surgical service of the Johns Hopkins Hospital, a concretion was present in the canal immediately beyond the portion involved in the tumor.

Age.—The age at which malignant tumors of the appendix develop is especially noteworthy. Of the cases conclusively shown to be instances of primary carcinoma, the ages are given in 69 instances. The youngest patients were (1) a girl of eight years, operated upon by Edgar A. Vander Veer. The case was reported by L. K. BALDAUF (*Albany Med. Ann.*, Dec., 1905). The microscopical diagnosis in this case was "carcinoma simplex." (2) A child eight years old reported by C. E. BRANDTS (*Münch. med. Wochenschr.*, 1907, vol. 54, p. 1780). The diagnosis in this case was "carcinoma solidum" with secondary perforation of the appendix.

The following table shows by decades the ages of the 69 patients where the ages were stated.

1st to 10th year.....	4 cases	50th to 60th year.....	2 cases
10th to 20th year.....	10 cases	60th to 70th year.....	2 cases
20th to 30th year.....	29 cases	70th to 80th year.....	1 case
30th to 40th year.....	19 cases	80th to 90th year.....	1 case
40th to 50th year.....	2 cases		

From this table it would appear that 58 cases or 86 per cent. were in the second, third, and fourth decades of life. The correspondence between the age at which new-growths so often occur and the age at which appen-

ditis is most common, suggests an etiologic relationship between the two. From an etiologic stand-point it may also be noted that, at an early age, the tip of the appendix is often undergoing a process of normal involution without evidence of inflammation, and in many of the recorded cases the tumor was situated in the tip, while the remainder of the appendix was normal, showing no trace of an inflammatory process.

Sex.—The disease apparently has a preference for the female sex, for among the 52 cases analyzed by Zaaier as to this point, 65.4 per cent. were in women and 36.4 per cent. in men.

CLINICAL HISTORY.—The clinical symptoms in practically all cases of carcinoma of the appendix which come to operation are the symptoms of chronic appendicitis or of perforative appendicitis without previous evidence of appendiceal disease. Of the cases described at autopsy death in some instances was due to general peritonitis following rupture of the carcinomatous appendix, no symptoms of appendiceal disease having existed previous to the fatal attack; in others the fatal termination was the result of the extensive invasion of neighboring structures by the growth; and in other cases the patient had presented no evidence of disease of the appendix during life, death being due to some intercurrent affection.

As the disease progresses peri-appendiceal abscess is a common sequela, and in one case in which the abscess was opened a sinus persisted which communicated with the lumen of the appendix, and finally became lined with the new-growth. In this case, although right iliac disease was present for three years, there was no disturbance of digestion. The iliopsoas muscle may be invaded and the ilium eroded, as in a case described by KOLACZEK. Extension to the cæcum probably occurs in a considerable number of cases. In ELTING's case the complete destruction of the distal portion of the appendix, and the intimate relation of the remaining part to the growth, show, fairly conclusively, that the carcinoma was primary in the appendix, but the possibility that it had originated in the cæcum cannot be denied. When the cæcum has become implicated, the appendiceal lesion is masked by the symptoms arising from the involvement of the direct intestinal canal; viz., disturbed digestion, alternating diarrhoea and constipation, melena, and obstruction. The tumor may give rise to an attack of acute appendicitis resulting in perforation and general peritonitis. Perforation of a carcinomatous appendix may also occur without previous warning of the presence of an abnormal condition. G. A. WRIGHT described an autopsy upon a case of purulent peritonitis of obscure origin. There were a few adhesions about the appendix but no definite evidence of perforation. As a routine procedure, sections of the appendix were made, and on microscopic examination a small carcinoma of the head of the appendix was found, and just at the junction of the tumor with the bowel there was a minute perforation which was the starting-point of the infection. The growth apparently was limited to the appendix. Routine examination of appendices will reveal many more cases of carcinoma in the future.

DIAGNOSIS AND DIFFERENTIAL DIAGNOSIS.—With one or two exceptions the recorded cases of tumors of the vermiform appendix were discovered at operation or on the postmortem table, and owing to the similitude of the clinical picture to that of chronic appendicitis, it is impossible with our present methods of examination to make a diagnosis, clinically at least, in the early stages of the growth. The discovery of a mass in the right iliac region, presenting the characteristics of a new-growth, and not accompanied by the signs and symptoms usually occasioned by a tumor involving the direct intestinal canal, is strongly presumptive of a tumor originating in the appendix. In the presence of a tumor mass the differentiation between a new-growth and inflammatory conditions is often difficult. In some cases the clinical history is of value. A sudden onset, associated with high temperature, leucocytosis, and other acute symptoms, indicates inflammatory disease. The sudden development of a tumor mass where none previously had existed also points to an inflammatory origin. As a rule, a new-growth is more definitely circumscribed, is not so firmly fixed, and is less sensitive on palpation. In BERGER's case a correct diagnosis was made before operation, being based upon the fact that the growth which lined the abdominal fistula showed the typical structure of intestinal carcinoma, that it originated in the region of the appendix and there were no symptoms referable to disease of the direct intestinal canal.

Tuberculosis of the hyperplastic form may readily be mistaken for a new-growth. The more cylindrical, less nodular shape of the tubercular tumor, associated with the presence of other tubercular foci, is the most distinctive feature. Bacilli would probably not be found in the stools, or at any rate but rarely, while the disease is limited to the appendix. The tuberculin test or the opsonic index may possibly aid in the differential diagnosis. Fortunately, in all these conditions an operation is indicated; even after the abdomen is opened the true nature of the disease is not always recognized, and often the new-growth when small is overlooked, or is considered to be simply an obliterating appendicitis. This is of little moment when, as is often the case, the growth occupies the tip of the appendix; but when it is situated near the cæcal end it is of vital importance.

While the usual mistake is that of considering a new-growth to be a simple inflammatory condition, the converse may also occur, and in some instances a chronic inflammatory condition, accompanied by excessive tissue production, has given the impression of a malignant neoplasm.

The finding of a distinct tumor in the appendix should always be regarded with suspicion, because innocent tumors are rare; whereas carcinoma is relatively common. While it is often impossible to determine the true nature of the growth when it is *in situ*, it can usually be recognized in the gross specimen by examining the cut surface and noting the relation of the tumor to the appendical walls. In doubtful cases, especially if a wide resection of the bowel is necessary, frozen sections should be examined at once during the operation.

PROGNOSIS OF CARCINOMA.—The time which has elapsed since the majority of the cases of carcinoma have been operated on is too short to permit of a positive statement regarding the prognosis. Up to 1903, only 4 cases had been discovered at operation, **BERGER'S** in 1882, **STIMSON'S** in 1896, and **WEIR'S**, reported in 1903. In the first of these, extensive invasion of surrounding structures had taken place at the time of operation and the patient died. Another case recently reported by **LEJARS** also died and I have not been able to obtain the later history of **Stimson's** case. **Weir's** patient remained well during the three years he was under

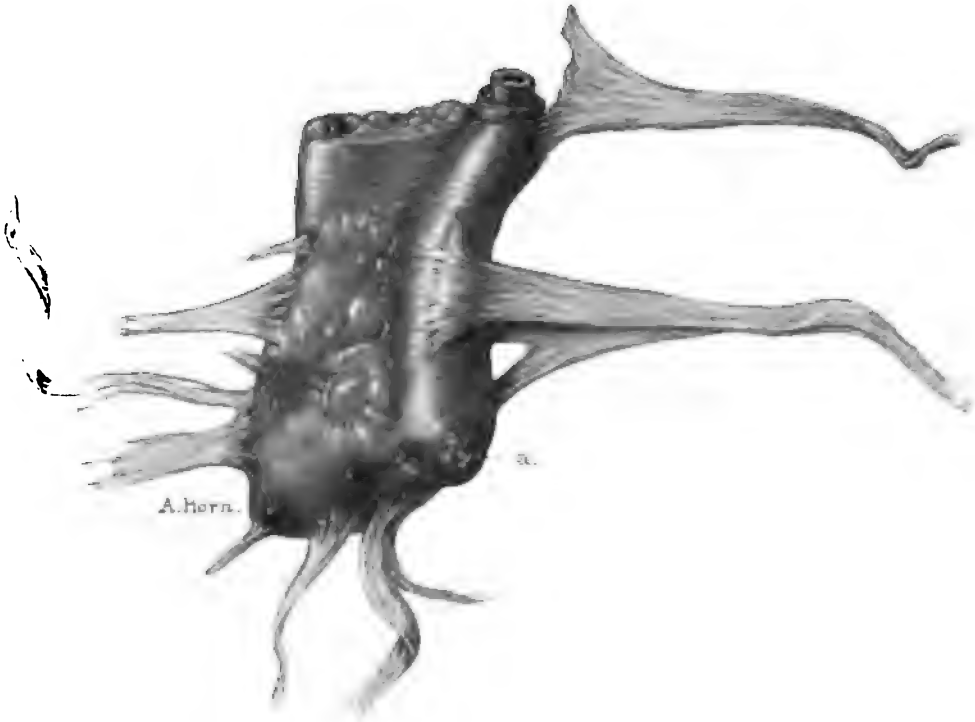


FIG. 204.—H. A. KELLY. INVASION OF THE TIP OF THE APPENDIX BY CONTIGUITY FROM A PAPILLARY CARCINOMA OF THE OVARY. a, PAPILLARY CARCINOMA. (Gyn. Path. No. 5607.)

observation. **McBURNIEY**, in May, 1903, wrote me that a patient operated on eighteen months before was in good health. A patient of **Thorndike's** two years after operation gave no evidence of return of the growth. The case which **HURDON** reported in 1900 shows no evidence of recurrence at the present time (1908). **MONK'S** case two years later was operated on for pelvic inflammation, and at that time there was no evidence of recurrence. **BURNAM'S** case, operated on one year before the report, was in good health when last heard from. **HALSTED'S** patient was living five years after operation. Of 25 cases observed by **Zaaijer** as to their subsequent histories, one was well and free from recurrence five and a half years after opera-

tion; four were well five years after; three, three years after; four, from two to three years; eight, one to two years; and four, four to twelve months after operation.

Secondary carcinoma of the appendix is not uncommon, occurring most frequently by direct invasion, apparently more often by contiguity than by continuity of structure, and occasionally by means of metastases. In a considerable number of cæcal tumors the appendix is involved; it is quite frequently invaded by tumors to which it has become adherent; and naturally it is involved in cases of general abdominal carcinosis. Out of 3 cases of malignant ovarian tumors to which the appendix had become adherent (observed in the gynecological service of the Johns Hopkins Hospital), in 2 the growth had invaded the appendical walls (see Fig. 204), and in another case a non-adherent carcinoma of the ovary had given rise to metastasis in the appendix. In these cases, as a rule, the growth had penetrated the peritoneal and muscular coats of the appendix, but had not involved the mucous membrane. In a case reported by WHIPHAM, a small carcinomatous tumor, situated in the mucous and submucous layers of the appendix, and associated with carcinoma of the ovary accompanied by general metastases, was regarded as primary, on account of the location, but it was probably a metastatic growth from the ovarian tumor.

Sarcoma.—Sarcoma of the intestine in general is rare, and NOTHNAGEL, in his enumeration of the distribution of the collected cases, did not note its occurrence in the vermiform appendix. LAMERS (I. D. Giessen, 1902) mentions two cases in the cæcum and one in the appendix. He also describes a new case of cæcal sarcoma in a boy six years old. From time to time cases of sarcoma of the appendix have been reported, but in the majority of these the description is very unsatisfactory. SONNENBURG merely mentions the fact that he has seen a case; GILFORD describes a case in which the sarcomatous tissue had formed around a concretion, but there is some question as to whether he was not dealing with a hyperplastic inflammatory process. Undoubted examples of sarcoma originating in the appendix are described by P. PATERSON and by J. C. WARREN, and a third case has been reported by T. CARWARDINE. On account of the rarity of sarcoma of the intestine and of the especial interest attached to these cases of sarcoma of the appendix, a brief account of each of these is given.

I. J. C. WARREN. (*Bost. Med. and Surg. Jour.*, 1898, vol. 138, p. 177.) A boy, six years old, entered the hospital with a history of a month's illness occasioned by what was supposed to be chronic appendicitis characterized by intermittent pain in the appendical region and slight fever. On admission there was a small tumor at McBurney's point. He was kept under observation for ten days, during which the subjective symptoms subsided, but the tumor remained. Operation showed a new-growth in the ileocæcal angle, instead of a suppurative inflammation, the surrounding parts being more or less glued together. The mass proved to consist of the greatly enlarged appendix, which was the size of a thumb in diameter, and of enlarged glands going back to the root of the mesentery. A piece excised for examination showed round-cell sarcoma. The cæcum, with part of the ileum and corresponding part of the mesentery, was then excised and the intestine anastomosed with a Murphy button. Complete recovery followed, and a personal communication in 1902, four years after operation, stated that the boy was enjoying excellent health, with no evidence of recurrence.

2. P. PATERSON. (*Practitioner*, 1903, p. 55.) A man, thirty-nine years old, gave a history of uneasiness in the right iliac fossa for three months, with occasional attacks of sharp pain, lasting for several days. His bowels were constipated during the acute attacks, but otherwise normal; he had never had any vomiting. When first seen, the patient was suffering from an acute attack, characterized by severe pain in the right iliac fossa, nausea, and anorexia. His temperature was 100.8° F.; his pulse 100. Palpation revealed a distinct, tender mass in the right iliac fossa. On operation the appendix was found much thickened, firm, and bound down by adhesions posteriorly, while the omentum was attached to its apex. The cæcum was also thickened for a radius of about one-fourth of an inch around the attachment of the appendix. The appendix, together with the thickened part of the cæcum, was removed, and the opening closed. The patient never rallied from the operation and died six hours later. Postmortem examination failed to show any trace of tumor formation elsewhere, and the part of the cæcum that remained *in situ* appeared healthy. The appendix was 16.5 cm. long and 10 cm. in its greatest circumference. The growth had apparently begun near the apex of the appendix and extended toward the cæcum, which was only slightly infiltrated. Histologic examination showed a round-cell sarcoma infiltrating all the coats with the exception of the peritoneum.

3. T. CARWARDINE (*Brit. Med. Jour.*, 1907, vol. 2, p. 1771) reports a case of round-celled sarcoma occurring in his practice in 1905. A woman, forty-five years of age, had severe pain in the right iliac fossa, loss of flesh, and diarrhœa, lasting for five months. At operation the appendix was found to be as large as a man's thumb, three and a half inches long, and hard as well as adherent. Its club-shaped extremity was deep down behind the ileo-cæcal junction. It was enucleated with considerable difficulty, and fractured like a carrot near its base. The cæcum and ileum were normal. A gland near the head of the cæcum was also removed. The patient died of recurrence nine months after the operation. There was no autopsy. Microscopic sections of the appendix, taken at intervals, showed it to be uniformly composed of round cells with a little intercellular reticulum. This pathological change involved the whole wall and at one point showed signs of healing through the peritoneum. Several pathologists saw the sections and pronounced the case one of sarcoma.

The operative treatment of neoplasms of the appendix will be found at the close of Chapter XXIII, pp. 459 et seq.

CHAPTER XXIII.

SPECIFIC INFECTIONS OF THE APPENDIX.

CLINICAL HISTORY

Tuberculosis.—Intestinal tuberculosis may be either primary or secondary. If the latter it occurs in the last stages of lung tuberculosis or follows tuberculosis of the uterine tubes or the cæcum. In many cases the resistance of the organism is so slight that the lesions become widely distributed over the intestine, and ulcers showing no tendency to heal are produced, which frequently advance to perforation with consequent fatal peritonitis. In a considerable proportion of these cases the perforation occurs in the appendix. Intestinal tuberculosis is of especial importance when localized in the ileocæcal region. In such cases the disease is usually primary, or if secondary has a comparatively insignificant focus in some other organ, usually the lung. The organism still having the strength to limit the tubercular process, the lesions show a tendency to healing with cicatrization of the ulcers, or to infiltration and connective-tissue proliferation (LENZMANN). RUDOLPH BONN (I. D., Berlin, 1897) called attention to the fact that in 1843 VON VALY and in 1844 VON BODARD gave a complete description of tuberculosis typhlitis; also that in 1851 ALBERS stated that perforation of the appendix did result from tuberculous ulceration, a fact verified by LEUDET in 1859.

It has long been known that the ileocæcal region is the favorite site for the localization of intestinal tuberculosis, whether secondary or primary, and since HARTMANN and PILLIET in 1890 called attention to the occurrence of the tumor-like tuberculous lesions in the intestine, this form of the disease has been found to be almost constantly confined to the ileocæcal region. Infection of the appendix commonly occurs by direct continuity from the cæcum, or as a local manifestation of a general infection; an infection of the bowel secondary to pulmonary tuberculosis, however, may be entirely localized in the appendix. FENWICK and DODWELL (*Lancet*, 1894, vol. 2, p. 133) found that in 17 cases occurring among 2000 autopsies on persons dying of tuberculosis, the intestinal ulceration was limited to the appendix. Furthermore, the appendix is often invaded through direct contact with a tubercular tube or ovary. Thus, out of 7 instances in which I have found the appendix adherent to the diseased pelvic organs, in 4 the tubercular process had invaded the wall of the appendix. In one, the appendix was involved in a general peritoneal tuberculosis, secondary to the tubal disease (see Fig. 205). Primary tuberculosis of the appendix is apparently rare. It is difficult to judge of its exact frequency, because in the absence of portmortem demonstration, the

presence of other foci cannot be positively excluded; while, on the other hand, many cases undoubtedly pass unrecognized, owing to their resemblance, both clinically and macroscopically, to ordinary acute or subacute appendicitis. L. H. PETIT (*Tribune méd.*, Paris, 1906, N. S. vol. 38, p. 5) got together 70 cases of tuberculosis of the appendix, 19 of them being before unpublished. He quoted LETULLE, who in 500 autopsies found 114 cases of tuberculosis of the appendix, 12 of them being primary in the appendix.

A few cases, however, have been described in which the evidence strongly pointed to a primary affection of the appendix, and was confirmed by the complete restoration of the patient's health after the appendix had been removed. The only definite examples which I have been able to find are the cases of the usual ulcerative form described by SONNENBURG and by McCOSH and HAWKES, and a case of hyperplastic tuberculosis described by CROWDER. MOSHER describes a case in which at operation the tubercular infection seemed limited to the appendix, but three years later the patient died of pulmonary tuberculosis. An additional case has been sent me by F. HENROTIN of Chicago, and two others have come under my own observation, one in my private hospital and the other in the practice of my associate, T. S. CULLEN. The nature of the lesions in these cases was wholly unsuspected until it was discovered in the course of the routine laboratory examination of the specimen. A third case, operated on for acute appendicitis, was found on microscopic examination to present advanced tubercular lesions, but on account of some thickening in the walls of the cæcum observed during the operation, as well as owing to the presence of hardened cervical glands, it seemed probable that the lesion of the appendix was secondary. (For clinical notes of the cases see "The Vermiform Appendix and its Diseases," p. 762.)

An analysis of six cases shows that, apart from the family history of tuberculous disease in two and the definite history of antecedent tubercular foci in one, there were no signs nor symptoms by which the affection could be distinguished from simple chronic or subacute appendicitis. The irregular diarrhoea, or alternating constipation and diarrhoea, often found with tuberculosis of the direct intestinal canal, was not observed, nor was there ever any blood in the stools. With the exception of one case the general health of the patient was not affected. WEINBERG and ALEXANDRE (*Bull. et mém. Soc. anat. de Paris*, 1906, vol. 81, p. 16), in reporting four cases of tuberculosis of the appendix, give the history of a case of "*appendicite tuberculeuse dysenteriforme*" in a man nineteen years old and describe the specimen removed. In this case there was loss of substance in the mucous membrane of the appendix, as is the case in the lining of the bowel in dysentery. The man died of tubercular abscess of the liver some months later.

The detection of the specific organism in the stools would be a valuable aid in the diagnosis, but, while the disease is limited to the appendix, it is not apt to be present. The tuberculin test would be only of negative value, as it is impossible to exclude other foci. Moreover, its use is scarcely

justifiable, since operation is advisable in any case. These cases of localized tuberculosis, as I have said before, are essentially chronic, and have a tendency to undergo fibrous transformation; it is apparently but seldom in an early stage that they are the source of a more general infection. As a rule, adhesions are present, which in the event of a perforation would tend to limit the infection to the right iliac region. Involvement of the regional lymph-glands, however, is frequent, and the invasion of the ileocaecal region is, finally, extremely extensive.

When tuberculosis of the appendix has involved the neighboring portion of the cæcum, or when it merely accompanies a primary cæcal or general intestinal affection, the symptoms are masked by those of a more



FIG. 205.—PERITONEAL TUBERCULOSIS INVOLVING THE APPENDIX, WHICH HAS BECOME PARTLY TWISTED ON ITS AXIS. (Mrs. P., April 12, 1902.)

pronounced character produced by the latter disease. In the ordinary, widely disseminated, ulcerative tuberculosis of the bowel which occurs in the late stages of a large proportion of all cases of lung tuberculosis, the gastro-intestinal symptoms are general, and are characterized chiefly by anorexia, by more or less constant diarrhoea, abdominal pain, irregular pyrexia, and frequently by the passage of mucus and blood in the stools. When the affection is localized in the right iliac fossa, acute symptoms are seldom observed, and the disease may advance so insidiously that the first evidence of its presence is the occurrence of sudden acute intestinal obstruction or of perforation.

T. S. CULLEN had a case of this kind ("Vermiform Appendix and its Diseases," p. 765), in which a strong Irish woman, twenty-four years old, gave a history of abdominal cramps occurring two or three times a

month for about a year. There were symptoms of perforation just before operation, and on opening the abdomen it was found that there was stricture of the ascending colon, just above the cæcum, completely occluded by a shot, and that there was a perforation in the cæcum directly opposite the ileocæcal valve.

The onset of the ileocæcal affection is usually indefinite, the earliest symptoms, as a rule, consisting of dyspepsia, anorexia, nausea, irregular diarrhoea and slight fever. When stenoses have formed, symptoms of chronic obstruction are common. Colicky pains in the abdomen and more or less flatulency, most marked in the cæcal region, constipation alternating with diarrhoea, and sometimes vomiting, are then prominent symptoms. The stools may show nothing characteristic; sometimes there is a great deal of mucus and occasionally blood.

The hyperplastic form of tuberculosis develops very insidiously. Colicky abdominal pain, at first occurring at long intervals, but becoming progressively more acute and more frequent, is the most constant symptom. The later symptoms are usually those of gradually advancing obstruction, accompanied with evening pyrexia, emaciation, and loss of strength. In some cases recurrent acute attacks, closely simulating recurrent appendicitis, are the most prominent features in the clinical history. As a rule, however, the patient does not entirely recover in the intervals. The most conspicuous physical sign is the presence of a tumor in the right iliac fossa. This may be so prominent as to be noticeable on mere inspection. It is more or less cylindrical, somewhat nodular, and as a rule possesses slight or no mobility. It is somewhat tender, but rarely acutely so. The disease may closely simulate a new-growth of the cæcal region, or a peri-appendical exudate. The age incidence of the disease corresponds with that of carcinoma. The most distinctive features in the diagnosis are the gradual development and the character of the tumor, which is more sharply outlined and less tender than a perityphlitic mass, while it is less nodular than a carcinoma and more nearly preserves the normal contour of the bowel. The shape may strikingly resemble that of a sarcoma. The latter condition, however, is too rare to frequently complicate the diagnosis. The detection of tubercle bacilli in the stools is of positive value, pointing directly to intestinal tuberculosis, because, as mentioned above, this localized tubercular process is seldom complicated with active tuberculosis elsewhere, so that the possibility of other sources for the organisms need not be considered.

Actinomycosis.—*Actinomycosis hominis* has only recently come to be regarded as anything more than a pathologic curiosity. LANGHANS (*Korrespondenzbl. f. Schweizer Aerzte*, 1888, Nos. 11 and 12) in 1888 showed that the vermiform appendix is the most frequent point infected in the alimentary canal by the ray fungus, and LANZ in 1892 spoke of "*Perityphlite actinomycotica*" as a distinct disease (*loc. cit.*, 1882, Nos. 10 and 11). GRILL (*Beiträge f. klin. Chir.*, 1890, vol. 13, Hft. 2) collected and analyzed all the cases published up to 1880.

He found in the literature 107 cases of actinomycosis of the alimentary canal. PONCET and BÉRARD (*Traité "chimique de l'actinomycose humaine."* Paris, 1898) published an extensive treatise on actinomycosis, and CONRAD BRUNNER ("Tuberculose, Actinomycose, Syphilis des Magen Darmkanals," Stuttgart, 1907) has summarized our present knowledge of appendicitis actinomycotica in his excellent monograph (*loc. cit.*, pp. 269, 275). MURPHY in 1885 reported the first case in America, but since then over 100 cases have been reported in this country by W. S. ERVING (*Johns Hopkins Hospital Bull.*, 1902), while ILLICH (*Beit. z. klin. Akt.*, Wien, 1892) collected 421 cases from the literature. In about 20 per cent. of these cases the disease was localized in the abdomen, and in the majority the avenue of infection was the vermiform appendix. It is seldom that cases of actinomycosis of the appendix come under observation until the late stages of infiltration and gross disease of the abdominal contents. A few cases have been reported, however, in which the disease was limited to the tip of the appendix (Bostrom and Barth, cited by Brunner). T. H. KELLOCKS (*Med. Press and Circ.*, Lond., 1906, vol. 82, p. 408) refers to three cases of actinomycosis limited to the appendix occurring in the Middlesex Hospital during the three years previous to October, 1906. MOSCHOWITZ (A. Vaud and E. Moschowitz, *Arch. f. klin. Chir.*, 1907, p. 704) refers to a case of extensive actinomycotic disease of the abdominal wall originating in the appendix that he had treated in the Mt. Sinai Hospital in New York.

Four cases of actinomycosis affecting the right side of the abdomen have been observed in the Johns Hopkins Hospital, 3 in the surgical department and 1 in my own clinic. The clinical histories of these cases were so strikingly similar that only one case will be cited as an example.

J. H. H., Gyn. No. 6961. A negress, twenty-eight years old, had spent most of her life on a farm. Five months before admission, while in good health and having had no symptoms of intestinal trouble, she was suddenly seized with intense colicky pain in the right lower abdomen. The pain continued several weeks, and at the end of the first week a swelling the size of a hen's egg was noticed in the region of the appendix. This swelling gradually spread throughout the entire lower abdomen. About a week before admission a small sinus appeared in the vicinity of the umbilicus discharging puriform material. The mass was hard and board-like and the abdominal walls densely infiltrated. The temperature was remittent, ranging from 99° to 100° F., with a leucocytosis of 12,000. An incision in the median line opened into a large necrotic cavity in the abdominal wall. The tissue removed showed actinomycotic infiltration. There was no attempt at healing, although the temperature fell to normal. About four weeks later, extensive lateral incisions were made and the potassium iodide treatment, begun a few days before, was continued. Marked improvement was then observed, the induration almost disappeared, and the incisions healed rapidly; but a few weeks afterward pain made its appearance in the right thoracic region, accompanied with fever. Two weeks later there was a severe chill, followed by a rise of temperature to 106° F.: the leucocytes at the time were 5800. There was tenderness over the liver and increase in its area of dullness. A few days before death, three months from the time of admission, definite signs of lung involvement appeared (see Fig. 80).

ETIOLOGY.—The disease is probably contracted from grain or from infected animals. It is most commonly found in farmers, cattlemen, and those concerned with the management of live stock or grain. In some instances there is a definite history of caring for infected animals, and in

several of the reported cases a grain of wheat or barley has been found in the midst of the actinomycotic mass. Men seem to be more frequently attacked than women, the proportion being about 3 to 1. The difference may be plausibly explained by the fact that men are more frequently employed about animals and in handling grain, and more often have the habit of putting grains or straw into the mouth. Any age may be affected, but the disease is most frequent about middle life. It may run a very slow course or may develop rapidly. In one instance it continued only four weeks; in another, thirteen years (ERVING), but, as a rule, the course is chronic, the parts affected early showing a tendency to heal while new foci are developing elsewhere. In the abdominal cases the clinical history at the outset resembles appendicitis. The onset is often acute, and is characterized by the occurrence of sharp, cramp-like abdominal pains, which continue more or less constantly for a few days or weeks, then subsiding and perhaps not recurring for two or three months. Generally, however, after the acute attack has subsided, more or less soreness persists and a tender swelling is noticed in the appendical region. In a case related by L. THÉDENOT (*N. Y. Med. Rec.*, 1900) the patient, a young man aged eighteen, who had been a groom, gave a history of a sudden attack of violent and continuous pain in the right iliac fossa. He improved, and operation was advised. On admission there was no pain, but great lassitude and anorexia. The appendix, which was apparently slightly inflamed and swollen, was removed and a gauze drain left in. The wound healed slowly and a very hard mass formed in contact with the appendix stump, which appeared to increase in size. Examination of scrapings showed the ray fungus, which had not been found in the appendix. In the 4 cases observed in the Johns Hopkins Hospital the onset was marked by sudden, severe colicky pains, occurring without warning while the patient was in good health, and not accompanied with nausea, vomiting, or other gastro-intestinal symptoms. The temperature is usually but slightly elevated in the early stages, but, owing to the liability of mixed infection supervening in the abdominal cases, a septic temperature accompanied with chills frequently develops. The leucocytes vary greatly, in some cases being almost normal, in others numbering 28,000 to 36,000. As the disease advances the most characteristic sign is the progressive increase in the mass and the brawny infiltration of the tissues. The rigid, board-like abdominal walls are not found in any other condition. Practically the whole abdomen may be involved, the older foci, as I have said, retrogressing while others form. The infection gradually extends to the surface, when sinuses, often multiple, appear and discharge a reddish-yellow puriform material, which is often extremely offensive. The characteristic sulphur granules are then usually seen. In rare instances the disease spreads superficially and remains localized in the intestinal membrane. Only two other cases of this sort (CANALI and CHIARI) have been described (O. DASKE, *I. D. Greifswald*, 1902). HOFMEISTER (*Beit. f. klin. Chir.*, 1900, vol. 26, p. 344) describes two unusual cases in which, without extension to the neighboring

structures, there was great thickening of the walls of the appendix and cæcum, that might have been confused with a neoplasm, especially sarcoma, or with hyperplastic tuberculosis. In such a case the nature of the disease is recognized by the appearance of the characteristic granules in the stools. The final event in the course of the disease is the occurrence of metastases, with the development of nodules in the lungs, heart, brain, liver, and other organs.

Amœbic Dysentery.—Amœbic dysentery is of interest in connection with diseases of the vermiform appendix on account of the comparatively frequent occurrence of perforation of this organ as a fatal complication of the disease. KARTULIS of Egypt has found a number of cases of infection with amœbæ in appendicitis, and SCHAUDINN in his experimental work with pathogenic amœbæ on rabbits noted a distinct amœbic appendicitis. ROGERS, who has observed a large number of cases in India, finds that the appendix is often severely affected and is especially liable to become perforated. As a rule, symptoms referable to the appendical involvement cannot be distinguished from the symptoms produced by the lesions in the cæcum and colon. The distinctive features of the disease are the "irregular diarrhœa, marked by exacerbations and intermissions, and progressive loss of strength and flesh." The stools are often bloody or mucoid at the outset, but later their chief characteristic is their fluidity. The detection of the amœba in the stools is the only positive evidence of the nature of the disease. In the event of a perforation the characteristic symptoms of perforative peritonitis develop and when the patient has been known to be the victim of the amœbic affection, the onset of peritonitis and its cause are readily recognized. In somewhat rare instances where acute symptoms are absent the nature of the dysentery is not recognized, and in such a case the sudden development of symptoms of perforative appendicitis may be referred to a simple appendicitis. As prompt surgical intervention is indicated in either case, this is of less importance, and at the operation the characteristic lesions are usually easily recognized.

The following interesting case of reinfection of the appendix by the amœbæ has been communicated to me by Captain KENNEDY, Assistant Surgeon U. S. A., from the service at the United States Army Hospital at San Francisco.

The patient was a man twenty-five years old, employed in the custom-service of the Philippine Islands. For the first two years of his service there he was in good health, except for some venereal infection from which he recovered without complications. In 1901 he contracted dysentery and malaria, from which he recovered in about a month. Until the spring of 1905, however, he had recurrences of both troubles, his health being apparently good in the intervals. In the spring of 1905 he had another attack of dysentery, for which he entered the hospital in Manila, where he remained several months. During his stay there he became much emaciated and had frequent stools (8 to 20 in twenty-four hours) which consisted largely of mucus. Microscopic examination showed amœbæ in abundance. In January of 1906 he sailed for the United States, being then much improved. While on the voyage, however, he had a severe relapse, and entered the army Hospital at San Francisco in November, 1906. On admission he was much emaciated, very weak, his pulse ranging from 100 to 110; his abdomen was sore and painful, generally

tender, but the tenderness was not localized. All other physical signs were negative. He was treated in the medical service of the Hospital for about three weeks, during which time specimens of the stools were examined on three different occasions, mucus being present each time, but not *amœbæ*. He made practically no improvement during this time, and his physician advised an operation for appendicitis in order to irrigate the bowel through the opening. He was prepared for operation without further examination and was not seen at all by Dr. Kennedy until he was on the operating table and under the anæsthetic. When the abdomen was opened, it was found impossible to lift out the appendix and it was necessary to enlarge the opening. The enucleation of the appendix was tedious, but eventually accomplished. The bowel, except for the appendix, seemed quite healthy, and, as no *amœbæ* had ever been found in the stools, Dr. Kennedy suspected that the appendix was the whole cause of the trouble. The organ was therefore removed, the abdomen closed, and the man made a perfect recovery. He began to improve immediately, he gained in weight and when seen about three months after the operation he appeared to be in perfect health and weighed more, he said, than he had ever done before. The appendix was examined by Captain F. F. Russell, who reported that he found *amœbæ* in it.

OPERATIVE TREATMENT OF NEOPLASMS AND SPECIFIC INFECTIONS.

Operation for Diseases Limited to the Appendix.—**TUMORS.**—The operation for removal of a polyp, a myoma or a carcinoma of the appendix differs in no important respect, as a rule, from the extirpation of the appendix for other causes.

Polyps of the appendix, so far as they have yet been observed, appear to be little, soft tumors which may not be discovered before the removal of the organ, or if they attract attention earlier, are noted simply as thickening of the appendix.

Myomata, on the other hand, in the three cases reported, were little nodules not unlikely to be mistaken for chronic inflammatory thickening; they might also be mistaken for carcinoma.

The **carcinomata** (adeno- and colloid) are the only other tumors limited to the appendix. The **adeno-carcinomata**, which have never yet been diagnosed before operation, appear, as a rule, as little circumscribed nodules usually associated with peri-appendicitis, and in several instances with perforation. Bearing in mind the marked characteristics of this affection, and the fact that it occurs with a frequency hitherto unsuspected, as shown by the number of collected cases (see Chap. XVII), operators will, no doubt, be more alert in future concerning it, and more ready to suspect the nature of the disease with which they have to deal, even before it is established by microscopic examination. An incision through the nodule while the patient is on the operating table, will often give unmistakable evidence to a practised eye. The treatment is a wide excision extending well into the mesenterium, and a painstaking investigation for glandular metastases. Where the disease has extended beyond the appendix into the neighboring cæcum, a resection of the appendix, together with a wide resection of the cæcum, is the proper course. This method must also be pursued in those cases, carefully noted, in which the disease has localized itself near the base of the appendix. In two instances in which the glandular metastases were so far advanced that an operation was out of the question there was no cæcal involvement whatever.

I know of but one case of **colloid carcinoma** of the appendix

which has been the subject of operation, and this was ELTING'S. Elting's other case (Chap. XXII, Figs. 202 and 203) was one in which, as will be seen from the reproductions, the mass could easily have been extirpated, as it was perfectly localized in the appendix.

The only cases of *sarcoma* of the appendix which have been operated upon, so far as I know, are those of J. C. WARREN, P. PATERSON, and T. CARWARDINE (see Chap. XXII). In each of these the appendix was enlarged and thickened and the disease extended a short distance upward into the cæcum. In operation upon one of them the excision was made just beyond the growth, while in the other two the entire cæcum was extirpated.

TUBERCULOSIS.—A simple tubercular process limited to the appendix may assume an *obliterative* form like that of a uterine salpingitis, or it may appear as an acute appendicitis, with ulceration of the mucosa and surrounding adhesions. Such cases need no special comment from a surgical standpoint, as they differ in no way from other cases of appendicitis to the naked eye, and the nature of the process is discoverable only after a microscopic study of the part removed. In CROWDER'S case of *hyperplastic tuberculosis* ("*appendicitis tuberculosa hyperplastica*") not only was the diameter of the organ much enlarged but the disease extended up into the neighboring cæcum as well. The removal of the disease was effected by an excision including the cæcum, a procedure which requires no special description.

Operations for Ileocæcal Tumors.—The fact that tumors in the ileocæcal region are frequently confused with appendicitis convinces me that their surgical treatment ought to be at least briefly described here.

Extensive operations upon the ileocæcal region with resection of the cæcum, of a part of the ileum, or of the ascending colon, or of both, are still more recent in their origin than operations for appendicitis.

The first case reported was that of H. KRAUSSOLD, in April, 1889 (*Volkm. Samml. klin. Vortr.*, No. 191; and *Centrbl. f. Chir.*, 1881, p. 186); it was performed for carcinoma attributed to a blow from a stone, received six years previously. The patient was a man, sixty-two years old, who had suffered for thirteen months from two fistulas with extensive fecal discharges. The cancerous disease involved the vermiform appendix, the cæcum, and the ileocæcal valve, all of which were excised, the head of the ileum being united to the end of the colon by Lembert sutures. The patient unfortunately died of collapse in two and a half hours; at autopsy the bowel was found tightly closed; there was involvement of one mesenteric gland, and a small metastasis was found in the liver.

The first successful operation was done by MAYDL, in 1882 (*Wien. med. Presse*, 1883, p. 438). R. SUCHIER, in 1889, reported what I believe to be the first successful operation for tuberculous stricture of the ileocæcal region (*Berl. klin. Woch.*, 1889, p. 617), treating it by excision and an end-to-end anastomosis, and resecting about 20 cm. of the cæcum and colon, the valve not being in the excised portion.

W. S. MCGILL, in an admirable monograph, the first in the English language upon this subject (*Ann. Surg.*, 1894, vol. 20, p. 642), says that CZERNY, in 1884, resected the ileocæcal valve for invagination on finding the valve cancerous.

WASSILIEF in 1886 did a resection to cure an artificial anus established for an acute invagination; and CZERNY again resected in 1892, this time for tuberculosis.

In 1894, when McGill's article was published, he was able to collect 104 operations, undertaken for various causes on tumors in the ileocæcal region, up to that date, and there presented.

METHODS OF OPERATION.—The first efforts of the surgeon should be directed to the discovery of the exact nature of the disease, as the operation will necessarily be more or less extensive, according as he has to deal with a mass of a simple inflammatory or tuberculous nature, or with carcinomatous or sarcomatous growth. He must, therefore, bear carefully in mind all the data furnished by the history, since these often suggest a probable diagnosis in advance of the inspection of the parts *in situ*. A history of a pulmonary tuberculosis, or a tuberculous process elsewhere, makes ileocæcal tuberculosis probable; moreover, in such cases the patient is sometimes cachectic for a long period, and is more apt to have suffered from stricture and obstruction. Carcinoma also may run an indolent course, and any marked cachexia may be wanting until the later stages of the disease. Bloody stools are more apt to be associated with carcinoma.

A long oblique incision, either transmuscular or in the semilunar line, should be made in order to expose the whole diseased area and give abundant room for the subsequent extirpation. The disease will be studied to better advantage if the incision is made somewhat toward the median line. As a preliminary measure the mass is then inspected, and its size, its extent up and down the bowel, and its amount of fixation noted; the possibility of an enucleation can then be roughly determined. The operator next turns his attention to the rest of the abdominal cavity in order to secure the valuable data furnished by metastases, which may at once determine the nature of an affection which is puzzling even after the abdomen is opened. This investigation assumes the more importance from the fact that DURANDE, BILLROTH, and HARTMANN and PILLIET (*Soc. anat. de Paris*, July and Dec., 1891), as well as SALZER (*Langenb. Arch.*, vol. 43), have shown that it is often impossible to distinguish a tuberculous process from one cancerous in nature while it is still situated in the body; it may also be impossible even when the resected bowel is removed from the body and held in the hand. Recalling this fact, the surgeon will treat every uncertain case as though it were a carcinoma, giving the patient the benefit of the doubt. When the abdomen is open, and before any steps are taken to pack off the intestines as a protection from any subsequent manipulations, the nature of the affection may sometimes, as I have said, be at once

determined by inspecting the metastases. A tubercular process may be disseminated all over the abdomen, or it may be discernible only in the form of characteristic little granules situated at the focus of the disease, in the neighborhood of the ileocæcal valve. Again, in tuberculosis the omentum may be infiltrated with tubercles; and multiple strictures of the bowel, if present, speak for tubercular disease. As COHN has shown (I. D. Freiburg, 1902), skin fistula as a complication is more frequent in tuberculosis than in malignant disease; 24 out of 48 tuberculous tumors in his investigation having been complicated by fistula, while MATALAKOWSKI's statistics showed only 2 complicating fistulas out of 17 carcinomatous tumors, and of these 2 only one was spontaneous. The smaller number of fistulas in carcinoma may to some extent be accounted for, however, by the fact that malignant disease is apt to destroy life before it has progressed so far.

BRUNNER (*Tuberculose des Magen Darmkanals*, Stuttgart, 1907) has collected and tabulated results of 53 operations performed, giving 37 operators for tuberculosis of the appendix, including my cases already in print. In all of these the diagnosis was by microscopic examination of the specimens. Two of the patients died as the result of operation, one from a perforated tubercular abscess and the other from collapse. Seven died later, six within a year, four of whom had fecal fistula. The end results of the remainder were undetermined. Of 19 who were sent home as cured, some remained entirely well at periods of two or three years and others died of general tuberculosis or peritonitis.

The hyperplastic form of tuberculosis is that which most often gives rise to errors in diagnosis under circumstances as favorable as those just described. One of the most characteristic signs of tuberculosis as a disease is the presence of caseous glands in the mesentery. The surgeon must also examine the omentum, for this may be converted into a carcinomatous roll extending transversely across the abdomen in the umbilical region, and so dense that it can be felt even before the incision is made; this condition, when it exists, affords a grave prognosis. Carcinomatous nodules, if not present on the peritoneum, may be found lodged in the deepest part of the pelvis. Another point in diagnosis is that the density of the carcinomatous nodules situated over the vertebral column differs from that of nodules caused by the tubercular process. The pylorus, the liver and the spleen should also be inspected or palpated for any malignant masses. In some instances an inflammatory process of unusual character arising from an appendicitis has transformed the bowel into a mass so rigid that it has been mistaken for malignancy and extirpated. Such an accident happened to one of my associates, who, not doubting the malignant nature of the disease, and, therefore, the urgent necessity of an extirpation, amputated the cæcum with the appendix and anastomosed the ileum into the colon end-to-end. With this possibility in mind, the operator should not allow the simplest inflammations to pass unsuspected, where the conditions admit of any doubt at all; in an urgent case

he may even make a small incision into the neighboring healthy bowel and introduce his finger, in order to investigate sufficiently to put the question at rest.

An actinomycotic process is recognized by the characteristic yellow granules and by its tendency to extend in every direction into all contiguous tissues, without respect to natural anatomic barriers. Actinomycosis advances by continuity and contiguity alike, and this is true of no other affection. A case has been reported recently by W. H. WYNN (*Brit. Med. Jour.*, 1908, vol. 1, p. 554), treated with a vaccine prepared from the infecting organism according to the methods of Sir A. E. Wright. It is possible that this means of treatment may prove of great value in handling actinomycotic disease of the appendix. In advanced stages of the condition, however, surgery must be the main reliance.

The real nature of the disease having been determined by this direct method of autopsy *in vivo*, the next question which arises is: Shall the operation proceed farther than the simple exploratory incision? The answer depends upon two factors: first, the vital status of the patient, that is, whether he is much exhausted or not; second, the stage to which the disease has advanced and its complications. As regards the patient, it may be said at once that the present tendency is to exaggerate lack of vitality and power of resistance. It is astonishing how much a weak patient will often stand if the operation is skilfully performed, without much exposure, chilling, and handling of the intestines, and, above all, if the adjacent parts are so protected, both during the operation and subsequently during drainage, that a peritonitis does not tread right upon the heels of an exhausting operation. Much here depends upon the skill and experience of the operator, and every man who deliberately undertakes a delicate and difficult task of this kind ought, at least, to have previously performed a number of successful resections upon dogs. Such an occasion is neither the time nor the place for maiden experience!

As regards the stage and extent of disease, there can be no doubt that a radical operation should be carried out when there is a reasonable hope of a successful issue, immediate and remote. If a carcinoma is so far advanced in its invasion of other parts that a speedy recurrence of the symptoms is to be looked for, it will not be wise to extirpate the primary focus in the cæcum, and a better plan is to do an entero-anastomosis, short-circuiting the affected area. In tuberculosis and in actinomycosis the outlook in attacking a great mass of diseased tissue is more promising, since it is well known that in these conditions perfect and permanent relief may follow a successful anastomosis after enucleation.

The appearance of a carcinoma is well shown in Fig. 206, which represents a case of my own that closely simulated an appendicitis in the presence of febrile crises with localized pain and tenderness. The only suspicious circumstance was the indolent nature of the rather hard mass. The appearance peculiar to carcinoma is shown in the cross-section *a*.

The alternative operations in any given case are:

1. A simple exploratory incision, associated, it may be, with the drainage of an abscess in carcinoma or in actinomycosis, any further attempt to operate upon the bowel being abandoned, on account of the patient's condition or the advanced character of the disease.



FIG. 206.—CARCINOMA OF THE ILEOCÆCAL VALVE (a) EXTENDING INTO THE CÆCUM (b) CLOSELY SIMULATING APPENDICITIS.

The ridge indicated the limits of the disease. Operation, H. A. Kelly, A. McC. San., Feb. 3, 1903; resection and end-to-end anastomosis. Death from recurrence sixteen months later. (Natural size.)

2. Simple entero-enterostomy, by means of a lateral anastomosis of a loop of ileum above the disease to the colon below it, thus short-circuiting the diseased area.

3. Complete exclusion of the diseased area, effected by amputating the bowel above it and closing the end or the ends leading into and out of the affected portion, at the same time anastomosing the healthy bowel from above to a point below the disease.

4. Extirpation of the diseased appendix and caecum, with so much of the ileum and the ascending colon as may be necessary, followed by the anastomosis of the ileum with the colon.

If, after the extirpation of the diseased portion of the bowel, the patient's condition is such that it is impossible to proceed with the operation of anastomosis, the ends of the bowel, distal and proximal, may be brought out onto the surface, so as to establish an *anus preternaturalis*. This should be closed by completing the anastomosis at a later date, which, of course, simply makes two steps of the fourth alternative, and is only to be adopted on account of urgent necessity.

The second alternative, a simple entero-enterostomy, short-circuiting but incompletely excluding the diseased area, is most valuable in cases of advanced disease where removal is out of the question, or where the patient has suffered so long from obstruction that his condition will only admit of the most essential, life-saving operation. An entero-enterostomy by means of lateral anastomosis of a loop of the bowel to the ascending or transverse colon, is the quickest and the simplest method, as well as that which affords most security of overcoming the difficulties, and giving prompt relief from the most urgent symptoms. BRUNNER (*loc. cit.*) gives a list of 36 cases treated in this way by 17 different surgeons, for the most part by Czerny, Albert, and von Eiselsberg, with a mortality of 8.3 per cent. In the majority of these cases the lowest loop of the ileum was anastomosed to the colon below the diseased portion of the bowel. In some instances, where the ileum was diseased or covered with tubercles, the jejunum was utilized. The Murphy button was employed in 8 instances. In many of the cases the tumor of the cæcum was diminished in size following the operation. This result corresponds with Conrath's experience in four cases.

In performing an entero-enterostomy, the first point of importance is to unite the nearest free loop of the ileum to the colon just beyond the diseased area, in order to short-circuit the disease effectively, and yet not throw out of function any more of the bowel than is necessary. In selecting a loop of the ileum for anastomosis into the colon, the surgeon must always bear in mind the definite disposition of the small intestinal coils in the abdomen, which, not unlike the convolutions of the brain, are subject to minor variations, but in their general grouping are always the same. This fact will be best understood by consulting Fig. 207, showing the mesenteric ruffle, which, of course, corresponds precisely to the arrangement of the intestinal coils that have been removed to facilitate the demonstration. The groups may be conveniently lettered and designated from duodenum to cæcum, as Group A, Group B, Group C, Group D, and Group E, the capital letter marking the center of its group, which is limited by the small letters preceding and following. The surgeon will at once perceive that if he were to pick up a loop of intestine under the left colic flexure from Group A, he would short-circuit almost the entire

intestinal canal, and starvation of his patient would inevitably result. The mistake he is most likely to make is to take a loop in B, and attach it to the ascending or the transverse colon, thus committing the serious error of throwing Groups C, D, and E out of function. The anastomosis should be made in E, which must be picked up and drawn over to the colon; or it must, at any rate, not be higher than D, in case E is too much involved in adhesions, as shown in Fig. 208, taken from an actual case



FIG. 207.—THE MESENTERIC RUFFLE, SHOWING THE GROUPS AND DISPOSITION OF THE COILS OF THE ILEUM.

A and B occupy the left and right, splenic and hepatic flexures of the colon respectively, and should always be avoided in any colic anastomotic operations. E lies in the small pelvis and is thus easily distinguished; more care must be taken in distinguishing C and D.

of VON EISELSBERG. The bowel, thus brought up, should lie in easy apposition, without folds, flexures, twists, or undue traction. The methods of making the anastomosis are the same as those employed for lateral anastomosis, shown in Fig. 209. Previous to the anastomosis the diseased area has been extirpated and the ends closed.

Complete exclusion, the third alternative, includes, according to WÖFLER (*Verhandl. d. dtsh. Gesell. f. Chir.*, 1889), unilateral as well as bilateral occlusion of the diseased portion. If a unilateral occlusion is done, the ileum is amputated above the disease and the proximal end

anastomosed into the colon by an end-to-side or a side-to-side anastomosis, while the distal end, leading into the diseased portion, is closed by suture. A complete bilateral exclusion is effected when the diseased bowel is cut free from the healthy ileum above and the colon below, yet is not removed. Experience and experiment have shown that the sequestered portion must have an exit, and this is to be provided in all cases by a fistula or by bringing one or both cut ends onto the surface. BRUNNER has collected 7 cases of unilateral exclusion and 23 of bilateral exclusion,

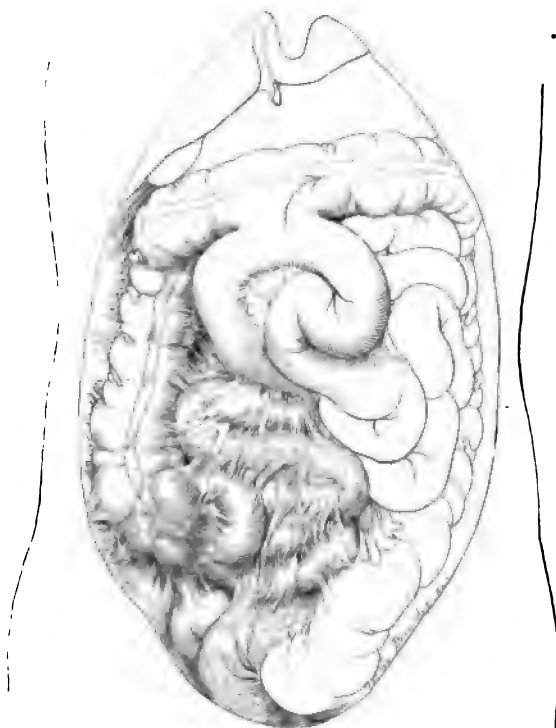


FIG. 208.—ANASTOMOSIS OF A LOOP OF ILEUM INTO TRANSVERSE COLON, AFTER A CASE OF VON EISELSBERG (*Arch. f. klin. Chir.*, Vol. 56, p. 303).

The last group and the ascending colon were not available here on account of the extensive adhesions.

including among the latter a case of Conrath's. Many of the former were extremely unfavorable cases, and the end results were accordingly bad. Brunner does not agree with Conrath's dictum that complete exclusion of the bowel is a more dangerous proceeding than excision or entero-anastomosis, and compares the 8 per cent. mortality of exclusion with the 25 per cent. mortality of excision. Lateral anastomosis was the method generally employed in the complete exclusion of the diseased gut. In most of the cases the tumor was diminished in size following operation, the general health much improved, the tumor freer from adhesions and in better shape for an excision to be practised at a later date. The method is applicable to cases of extensive disease about the head of the cæcum

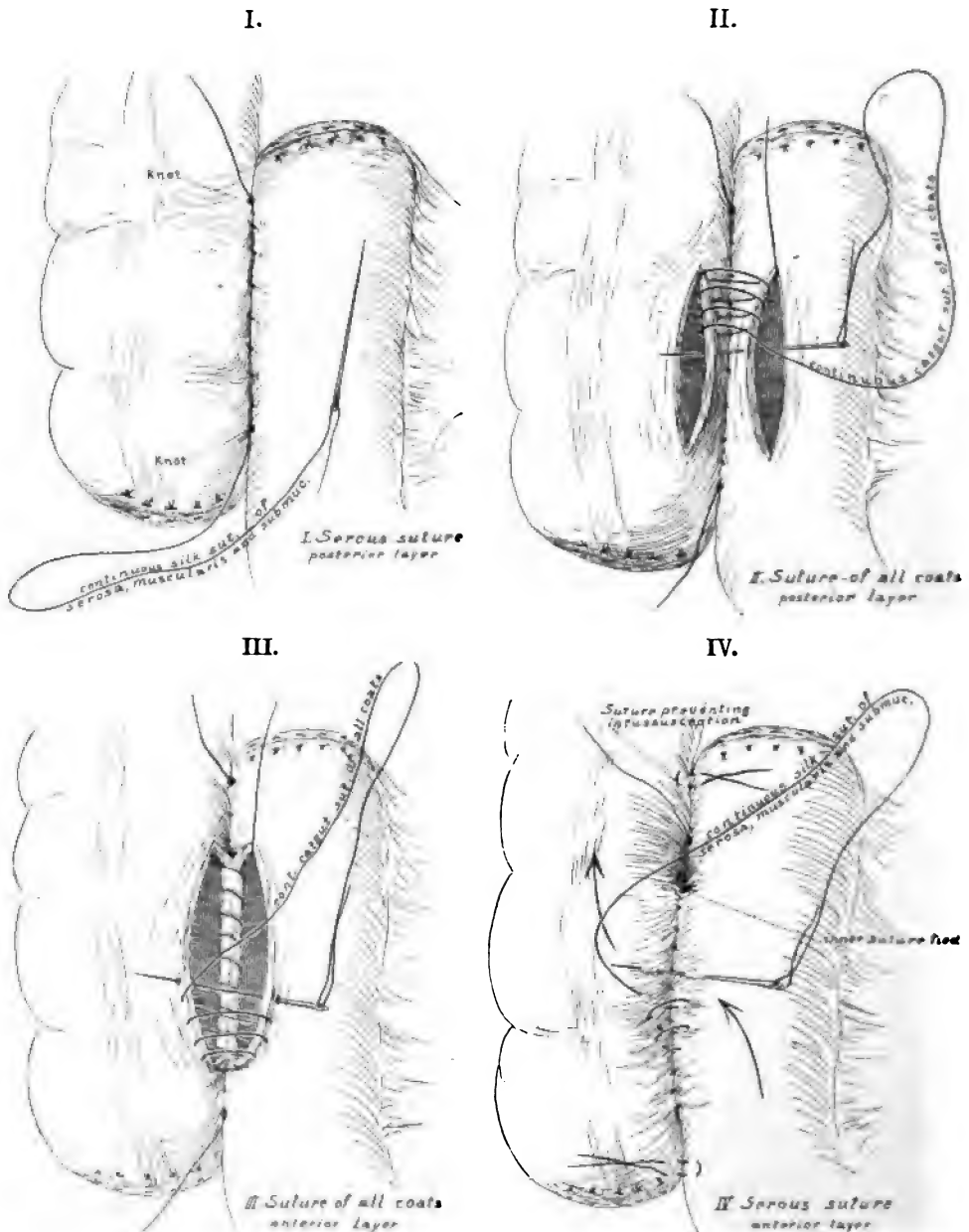


FIG. 209.—LATERAL ANASTOMOSIS AFTER HALSTED.

The ends of the bowel have been inverted by continuous or mattress sutures and the lateral approximation is made (I, left upper figure). Recently Cushing, Roux, and others, instead of the interrupted sutures used by Halsted, have employed continuous sutures which insure greater rapidity; puckering can be avoided if knots are tied at intervals. Then the bowel is incised and its margins united by suturing through all its coats, as shown in II and III. Lastly, the continuous suture first applied is continued so as to cover in the anastomotic opening completely, as shown in IV. Cushing has demonstrated to his class that if the blind pouches are left free, they may become intussuscepted and thus close the opening. To prevent this contingency, he sutures the pouches to the side of the intestine, as shown in the figure. (See p. 466.)

and colon, involving stenosis or a weakened condition of health contra-indicating operation.

We now come to the fourth alternative,—namely, the complete removal of the disease associated with the immediate suturing of the healthy bowel above it to the healthy colon below it. The great sources of danger from this operation are: insufficient closure in the line of suturing, resulting in infection and death from peritonitis due to contamination of the peritoneum with abscesses or with the foul contents of the bowel. The patient may also die of collapse if the operation is unduly prolonged. In one of the fatal cases of tuberculosis that have been reported the ureter was cut through and a nephrectomy was performed.

BRUNNER (*loc. cit.*) reports 125 cases of total resection of the ileocæcal region for tuberculosis, with an immediate mortality of 19 per cent. and a secondary mortality—*i.e.*, one including deaths resulting from secondary operations for anus preternaturalis, etc.—of 25 per cent. The operations were performed by 67 different operators, for the most part continental surgeons, Czerny, Mikulicz, Sonnenburg, Friedlander, Wölfler, Krajesski, Esmarch, Billroth, and Broca being among them. The incision along the border of the rectus muscle was employed in almost all instances. In the early years the end-to-end anastomosis was performed by such surgeons as Billroth; later, in the nineties, the lateral anastomosis came into vogue, and now the end-to-end anastomosis has resumed its former popularity, about half the cases in Brunner's clinic having been operated upon in this way. The Murphy button was used in 10 cases only. It often happens, as Brunner points out, that the ileum is dilated by the obstruction to the ileocæcal valve, so that in performing the end-to-end anastomosis there is only a slight difference between the calibre of the ileum and the colon.

The mortality for resection in cæcal tuberculosis (25 per cent.) is 28.7 per cent. better than in resections of the bowel for carcinoma, and 16.7 per cent. better than in the results of ileocæcal resections in general.

In ileocæcal tuberculosis it is important not only to excise the disease, but to remove any intimately adherent and suspicious areas of the neighboring small intestine as well. The method of end-to-end anastomosis is as follows: After packing off the rest of the abdomen with the utmost care, in order to avoid any contamination and the fatal peritonitis which is almost sure to follow such a misfortune, the affected area is freed on all sides, if fistulous with a portion of the abdominal wall attached, or with some of the densely adherent parietal peritoneum. The tumor mass is then brought outside and laid on compresses, while the assistant controls the bowel well above the disease, with his fingers or with a rubber band transfixing the mesentery. A clamp is applied close to the diseased portion and the small intestine is divided between the two. The diseased portion is then lifted up, exposing the mesenteric vessels going to it. The mesentery is next cut in the form of a V, including the entire diseased area. Care must be taken not to divide or ligate any of the vessels supply-

ing the bowel beyond the affected areas. As the mass is lifted, the colon is exposed, clamped next to the disease, and controlled by simple compression, without any controlling force beyond this, and divided between the two, thus completely severing the diseased portion, which is then re-

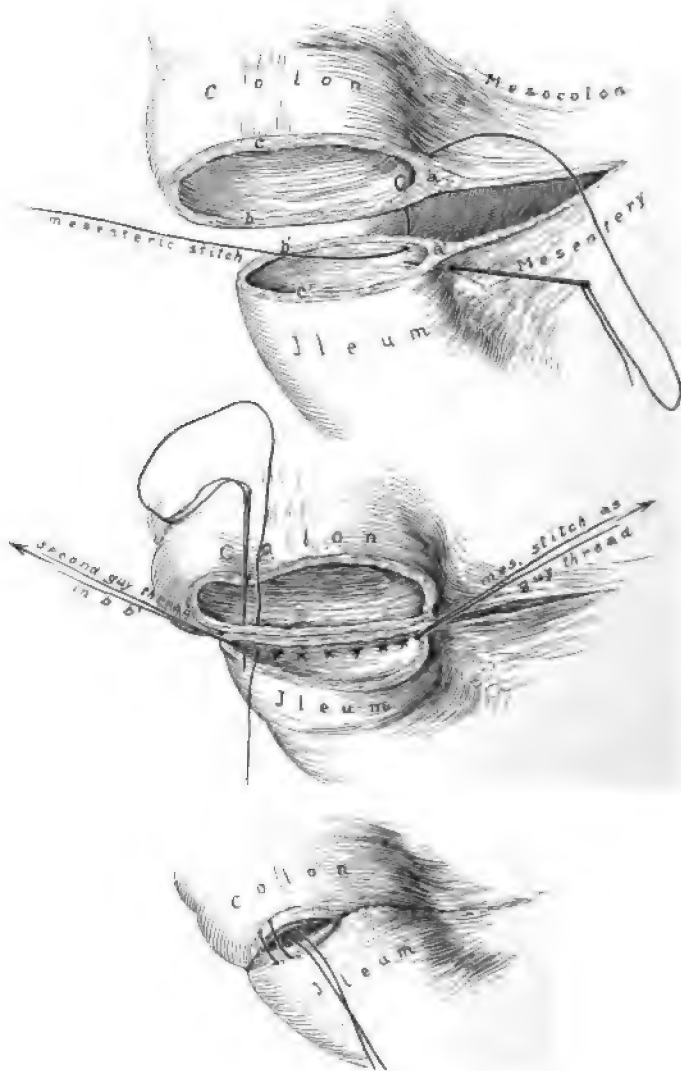


FIG. 210.—STEPS IN CONNELL'S OPERATION FOR INTESTINAL ANASTOMOSIS BY SUTURE WITHIN THE BOWEL AND TRANSFIXION OF ALL THE COATS, INCLUDING THE MUCOSA.

moved. The exposed mucosa is carefully cleansed, and the end-to-end anastomosis is then made by one of several plans. In event of haste Murphy's button, which has found such wide acceptance, may be used; otherwise a deliberate suture which secures careful union by two or more rows of fine silk sutures is always preferable. For this purpose I would

recommend following one of two plans. HALSTED's method of using inflatable rubber bags, which serve to equalize any inequality in the lumina which may exist, is simple and satisfactory. The bowel ends are basted together, as it were, by three or four sutures; the collapsed bag is then inserted between them and inflated. The accurate apposition of the ends by two layers of mattress sutures, first sero-muscular and then sero-serous, is now easily effected. The sero-serous, which is protective, may be made continuous to save time. Especial care must be taken to bring the mesenteric border into snug apposition, as this is the weakest feature of the operation.

Another most satisfactory plan of suture is that employed by CONNELL. Fine silk sutures are used and all the suturing is done on the inside of the bowel, as shown in the illustrations (see Fig. 210). The mesenteric stitch, applied as shown at *a a* in the upper figure, secures snug apposition at this point, and it is left of sufficient length to act with a second stitch applied at *b b*, about one-third of the way around the lumen, to hold the bowel taut and the edges together, while mattress sutures are applied through all the coats, as shown in the middle figure. Another gut suture at *c c* (upper figure) serves, together with those at *a a* and *b b*, to facilitate the application of the remaining sutures, all of which enter, emerge, and are tied on the mucous surface. The author himself takes pains to apply even the very last suture on the inside, but this is unnecessary. The last two or three sutures may be placed through the serous and muscular coat on the outside. A continuous suture, outside of the row just described, serves to support it and gives an additional security. A lateral anastomosis may be effected after closure of the amputated ends by the method shown in Fig. 209 (p. 468), where the opening from bowel to bowel is united on all sides by a continuous silk suture including all its coats, and protected by a sero-serous suture, surrounded on all sides as described in the legend.

CHAPTER XXIV.

HERNIA OF THE APPENDIX.

THE free mobility and uncertain length of the cæcum and the variations in its position due to developmental anomalies (see Chap. II.) are such that the appendix may be found in any region of the abdomen and in close relations with the various abdominal rings, in which it may, finally, become engaged. As a matter of fact, this little organ has been discovered in the inguinal and femoral canals on either the right or left side, and also within the umbilicus, within the obturator foramen, and in the various retrocolic and retrocæcal fossæ. The appendix may be found in a hernial sac, either as its sole content or in combination with other portions of the bowel or with the omentum. The earliest observation of a hernia of the appendix is probably that of MORGAGNI in 1751 (JOPSON, *Univ. Med. Mag.*, 1900). Another was soon after reported by SOEMMERING, and then one by MORSE, who in 1802 (GRAZIANI, *Thèse de Montpellier*, 1900) mentioned a case of crural hernia containing the appendix. In the collection belonging to the Hunterian Museum in London there is a specimen, accompanied with a history of a right inguinal hernia, which had proceeded to abscess formation and was finally opened, discharging feculent pus, a good recovery following. At autopsy, thirty years later, the cæcum was found adherent to the internal ring by the area corresponding to the site of the appendix: the latter, however, had entirely disappeared. Only isolated examples of appendical hernia are to be found in the literature up to the time when the radical cure of rupture became customary, but it is now known that the appendix is present in from 1 to 2 per cent. of all hernias. Of 101 cases analyzed by PRÜSS (I. D. Prüss, Halle-Wittenberg, 1902), 21 per cent. occurred in children of two years and under; the relative number of cases then diminished until the fifth decade, when a sudden marked increase was again noticed. The cases collected by RIVET (quoted from Jopson) also showed that the affection is more common in young children and in advanced life than in early adult and middle age. Men are affected more often than women, the proportion, according to Rivet, being 70 per cent. in the former to 30 per cent. in the latter; while Prüss gives 78 and 22 per cent. There is, however, a great preponderance of the femoral variety in females. The inguinal form constitutes from 70 to 80 per cent. of all cases, the femoral 20 to 30 per cent., while only 2 or 3 cases of umbilical and one of obturator hernia have been reported. In ECCLES' report of the cases at St. Bartholomew's Hospital there were 13 femoral and 16 inguinal hernias of the appendix.

The hernia may be congenital or acquired. I have found only two cases (SANDEFORT's and LETTAU's) in which the hernia was observed at birth, but if by congenital hernia is understood a congenital predisposition, namely, a patent funicular process, many of the cases fall under this head, a large proportion occurring, as I have said, in infants. SANDEFORT's case (quoted from Graziani, *loc. cit.*) was that of an infant born with a scrotal hernia which did not receive any attention until three months later, when a bandage with pressure was applied under the impression that reduction was complete. Soon symptoms of strangulation developed and death followed. An autopsy showed that the hernia was formed by the cæcum, the termination of the ileum, and the vermiform appendix, the latter being adherent to the testicle and to the bottom of the sac, and on account of the hardening of the appendix it was judged that the adhesion had taken place during fetal life. LETTAU's case (*Deutsch. Zeit. f. Chir.*, 1903, vol. 70, No. 2, p. 84) was an example of the umbilical form and was mistaken for a patent Meckel's diverticulum. At operation the appendix was found to be the only content of the sac. Congenital hernia of the appendix is generally ascribed to the formation in the foetus of adhesions between the appendix and the peritoneum covering the testis and gubernaculum. ROKITANSKY, VIRCHOW, ORTH, and others claim that the peritoneum in the foetus is frequently the seat of a chronic or acute inflammatory process, and that the resulting adhesions are often the cause of anomalous positions of the abdominal organs. With few exceptions, in the cases observed in children, the appendix is adherent.

The principal causes of the acquired form are, unusual mobility and length of the cæcum and appendix, and, what amounts to the same thing, the descent of the colon in general enteroptosis. The causes usually in action in the causation of hernia in general, contribute to produce appendical hernia as well. It is probable, as pointed out by PRÜSS, that, in many cases, the cæcum or some other portion of the bowel enters the sac with the appendix, but while the former returns to the abdomen, the latter, on account of its length and small diameter, or because of adhesions, remains in the sac. The presence of adhesions between the appendix and omentum may result in the former being forced into a hernia at the same time as the latter. In a case of J. M. T. FINNEY (*personal communication*) the sac contained a large incarcerated omental hernia, while the appendix was found in the outer posterior portion of the canal, but was entirely extraperitoneal, its inner surface only being covered with a reflection of the sac. The factors concerned in producing left-sided hernias are congenital anomalies in the position of the cæcum and appendix; as, for instance, when the cæcum occupies the left iliac fossa owing to failure of development of the transverse colon, or in cases of *situs transversus*. Again, a long cæcum and appendix, especially when associated with descent of the colon, may extend across from the right to the left side. Deformities, such as scoliosis and kyphosis, may, as FOERSTER claims (*Univ.*

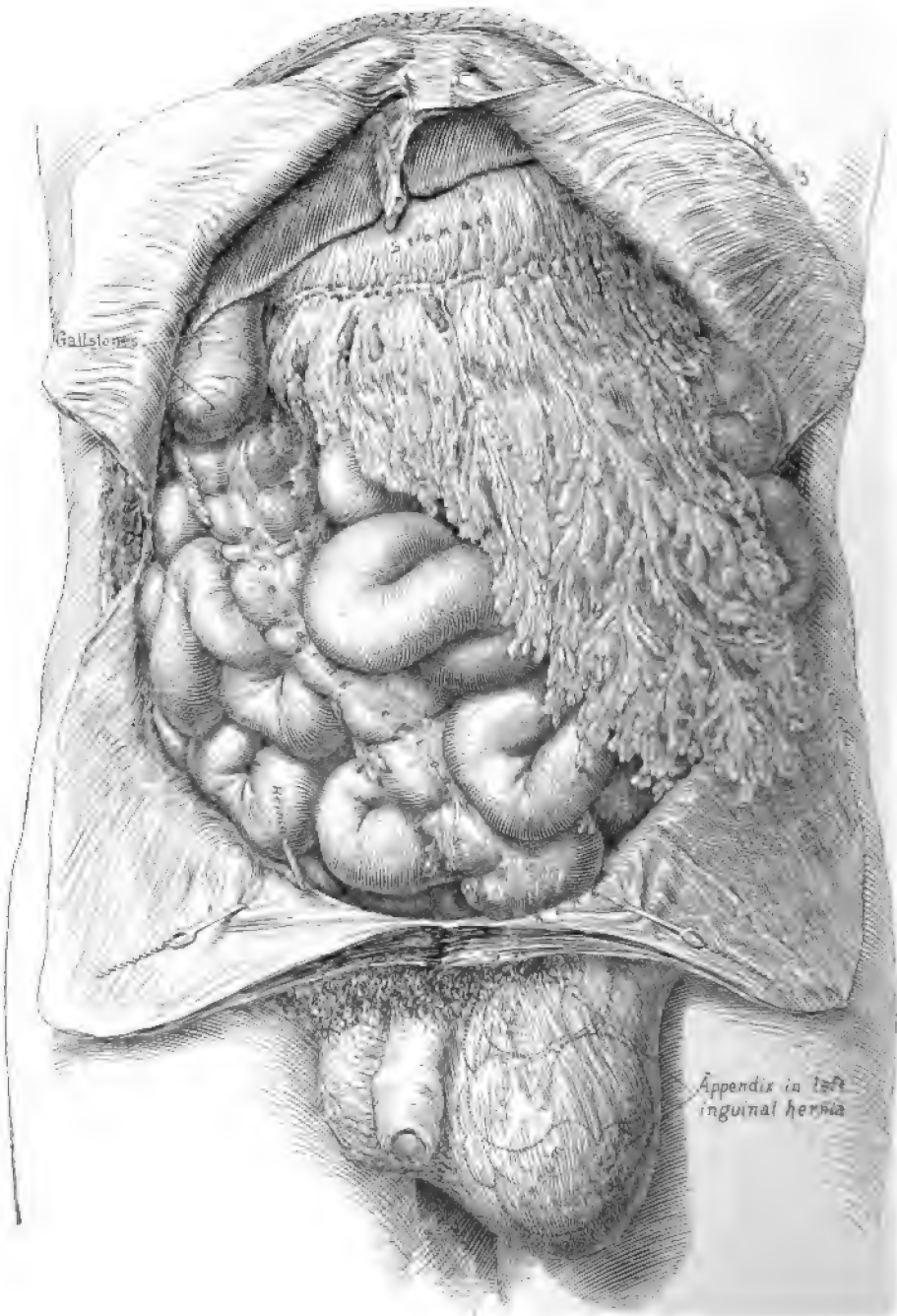


FIG. 211.—APPENDIX, WITH THE CÆCUM AND BEGINNING OF ASCENDING COLON, IN A LEFT INGUINAL HERNIA.
J. H. H., July 12, 1903. Autopsy No. 2136; age eighty-one.

of *Pa. Med. Mag.*, 1901), be etiologic factors in producing left appendical hernias. A large iliac hernia on the left side in old individuals with lax abdominal walls may draw the cæcum and appendix into the sac. This was evidently the mechanism of the case shown in Fig. 211, which was observed in an old man of eighty-one years who had entered the Johns Hopkins Hospital suffering from general arteriosclerosis and having a cardiac aneurism. The abdominal walls were greatly relaxed and there was an easily reducible inguinal hernia on both sides, the left being much the larger.

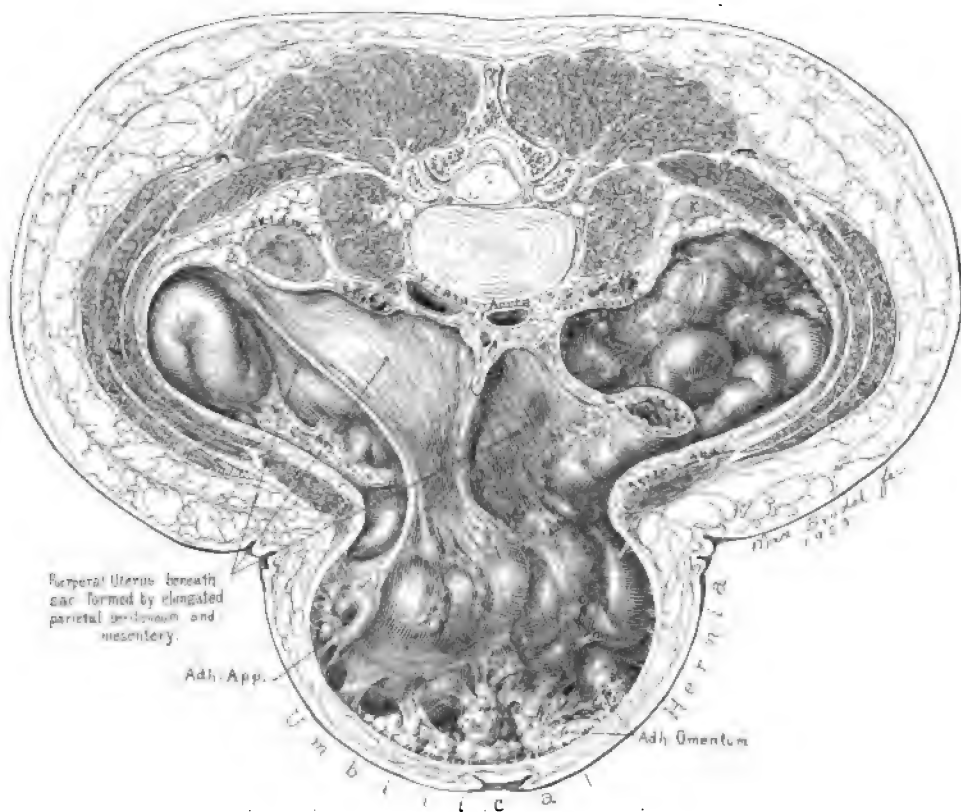


FIG. 212.—THE APPENDIX, CÆCUM, COLON, SMALL INTESTINE, AND OMENTUM, ADHERENT IN UMBILICAL HERNIA.

The appendix rarely forms the contents of an umbilical hernia, two instances only, so far as I know, having been reported, namely, that of LETTAU, already mentioned, and a case related by JEANNIEL (cited by Prüss). I have met with one example of this form of hernia (see Fig. 212), observed at autopsy on a woman aged twenty-five, who had died of acute miliary tuberculosis during the puerperium. BARY (I. D. Greifswald) recorded a fatal case in which the appendix was adherent in the obturator foramen.

The various complications which may arise are irreducibility, strangulation, and inflammation. The irreducibility

of the appendix is usually the result of the adhesions which are commonly present, but, as Jopson remarks, the fact that the easily reducible hernias are often not operated upon makes it impossible to estimate the frequency of its occurrence. Kinking of the appendix may prevent its return to the abdomen, and also cystic distention, as in the cases described by WÖLFLE (Arch. f. klin. Chir., vol. 21, p. 432) and VAN HOOK (*Med. and Surg. Rep.*, 1896). Strangulation and inflammation cannot always be differentiated before operation, and as strangulation induces inflammation, and

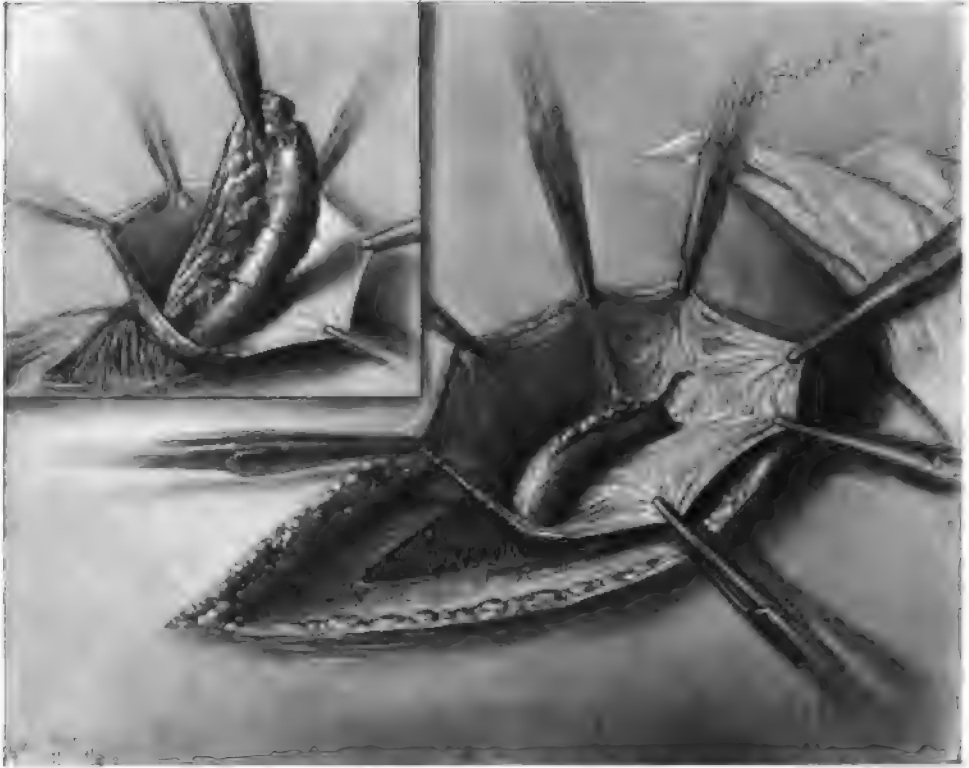


FIG. 213.—THE APPENDIX IN A RIGHT INGUINAL HERNIA.

The appendix was thickened and rigid, but free from adhesions. Man, age sixty-seven.

vice versa, it is often difficult, even at operation, to determine which was of primary occurrence. Chronic or acute inflammation may, however, develop without evidence of strangulation. It is produced by the usual causes of appendicitis, especially trauma, and gives rise to the characteristic symptoms of the affection.

The case of right inguinal hernia represented in Fig. 213 was that of a sailor aged sixty-seven, who had first noticed the swelling in the groin shortly after a severe strain in lifting. The hernia was easily reduced and kept in place with a truss, but the patient desired a radical cure on account of the pain experienced when walking without the support. The sac, which was of considerable size, was found empty except for the tip of the thickened, indurated, but not adherent appendix.

In another case occurring in the practice of my associate, G. L. HUNNER, acute gangrenous appendicitis in a right femoral hernia developed without producing any symptoms of strangulation. The patient, a woman aged sixty-nine, gave a history of attacks of abdominal pain sometimes located about the umbilicus, at other times across the lower abdomen. Her bowels were habitually constipated. Three days before admission to the hospital she began to suffer from rather severe pain in the lower right abdomen and for the first time noticed a swelling in this region. There was slight fever, but no nausea nor vomiting. The abdomen was soft and natural-looking, except for the swelling in the right lower quadrant, where a somewhat tender mass extended a few centimetres above Poupart's ligament and into the groin. The skin over the mass was infiltrated and indurated as well as slightly reddened. Operation showed that the entire appendix, with a small portion of the cæcum, was gangrenous, the distal half forming the contents of a femoral hernia (see Fig. 214).

Acute perforative appendicitis in a hernial sac has frequently been described and in several instances has been associated with the presence of foreign bodies and has sometimes followed traumatism. Several cases have been described in which the cæcum and proximal portion of the appendix were contained in the sac, while the tip of the appendix passed back into the abdominal cavity. In such cases the tip may become gangrenous or perforated, while the part in the hernia is only slightly inflamed. Symptoms of complete obstruction probably reflex in origin may develop in cases of strangulated appendical hernia. As a rule, the obstruction is found to be less complete than when other portions of the bowel are involved.

The diagnosis of appendical hernia from other forms is seldom possible. It may easily be mistaken for an omental or a Richter's hernia,—that is to say, a hernia in which only part of the caliber of the gut is protruded. Sometimes when the appendix occupies the sac alone it can be felt as a cord-like structure. COLEY (*Ann. Surg.*, 1895, vol. 21, p. 385) succeeded in making a correct diagnosis in two instances, in one of which it was based upon the fact that after reducing the hernia, a small and evidently adherent portion remained. In the other case, the hernia, which was small, was easily reduced, but traction upon the testis caused it to return, thus demonstrating the presence of adhesions.

Treatment.—Operations for the relief of hernia in the appendix are of two kinds, namely, of election or of necessity. An operation of election is one performed when there is nothing in the circumstances to make it urgent and it is a matter of choice with the patient, who desires to get rid of his hernia, and decision with the surgeon, whose services are to accomplish this end. An operation of necessity is one which is urgently demanded on account of strangulation, or the supervention of an inflammatory condition in the sac.

When the sac is opened, the operator may find its contents to consist of the appendix alone, or of the appendix and cæcum together, associated, it may be, with more or less of the adjacent bowel. If the appendix and the associated bowel are perfectly normal and free from adhesions, and if there have been no previous suspicious attacks of pain and tenderness in the sac, they may be returned to the abdominal cavity. In my judgment, however, it is better, as a general rule, under such favorable condi-

tions for exposure and manipulation, to remove the appendix by ligating its mesentery, and then amputating the organ, and suturing the orifice, according to one of the plans described in Chap. XVII; after which the



FIG. 214.—HUNNER'S CASE. GANGRENOUS APPENDIX IN A RIGHT FEMORAL HERNIA. THE OVERLYING TISSUES INFILTRATED AND ACUTELY INFLAMED. Woman, age sixty-nine.

hernial sac is closed *secundum artem*. In grave cases, where there is supuration in the sac, it must be drained, and here, as well as in the cases where there is gangrene in the appendix, resulting from strangulation (see Fig. 214), the utmost care must be observed in handling the diseased

tissues in order to avoid inoculating the peritoneal cavity. If the diseased portion is found to extend up into the peritoneal cavity, the operator must, at all hazards, discover the upper limits of the infection and resect the bowel in its healthy portion. Moreover, he must do this with the least possible manipulation and traction upon the parts, preferably by enlarging the abdominal opening in the direction of the canal, while protecting the healthy regions and keeping the disease well isolated by abundant gauze compresses. When the infection extends still further up into the abdomen, an even wider incision must be made if necessary in the form of an inverted T in order to provide abundant drainage after removal of the disease. In such cases the cure of the hernia becomes a matter of secondary consideration, to be taken up after recovery.

CHAPTER XXV.

MEDICO-LEGAL ASPECTS OF APPENDICITIS.

THE existence of a legal status in certain cases of appendicitis is not, as might be expected, a matter of only recent recognition. As far back as 1837, PETREQUIN, in his well-known article on the value of opium in perforation of the intestines, and of the vermiform appendix in particular (see Chap. XVI, p. 252), commented on the legal aspects of such cases as follows: "Are not intestinal lesions of this kind (spontaneous perforation) really a branch of legal medicine? Monsieur Alphonse Devergie says that the study of spontaneous perforations is of special interest to the medical lawyer; the collection of symptoms to which they give rise and the pathologic alterations which follow in their train being capable of simulating poisoning and occasioning symptoms which attack individual reputations." LARRET-LAMALIGNIE, writing in 1862, also emphasizes the resemblance between the symptoms of arsenic poisoning and those of perforation of the appendix. A medical man studying history, and reading between the lines, must often feel a conviction that many of the suspected poisonings so common a few centuries ago were, in reality, only cases of acute and fulminating intestinal affections, and not infrequently of appendicitis and peritonitis; literary investigation along these lines offers a field of interesting conjecture to any student of history gifted with the necessary insight. A case of fulminating appendicitis is not so likely to-day to be mistaken for one of acute poisoning in any well-organized community, for the universal suspicion of the poisoner as well as of the evil eye is now a thing of the past; moreover, the symptoms of appendicitis are at present so well understood that it is immediately suspected not only by the medical attendant, but often by the patient himself or his friends. Still it is possible that such an error might arise and demand investigation, although the risk to-day is rather in the opposite direction,—namely, that a veritable poisoning will be labelled appendicitis, and so escape recognition.

A new field of inquiry, however, has appeared since PETREQUIN's time, arising from a long-standing conviction that a causal relationship exists between appendicitis and trauma. This may be a matter of considerable importance.

The naturally protected position of the appendix, lying as it does against the posterior abdominal walls and covered by intestines, would seem at first sight to negative the possibility of any injury from a direct trauma, unless of the severest character. There is abundant evidence, however, to the contrary, and the medico-legal complications which may arise in

cases of appendicitis occasioned by such common and apparently trivial injuries as a blow, a kick, a contusion, or even a violent strain are numerous and interesting. From this standpoint appendicitis becomes of importance to life insurance corporations where there are limitation clauses in the policies, as well as in benefit associations where insurance is guaranteed for bodily injury but excluded in spontaneous internal disease, or when, on the contrary, the patient is insured against ordinary ailments, but not against accident.

It has already been noted (see Chap. IX) that the number of cases in which appendicitis is associated with injury or violence is much greater than is generally credited, and it follows that the desire to establish the connection between appendicitis and trauma should receive greater attention in the future. It is a curious fact that patients are prone to account for tumors, notably of the breast or in the abdomen, by a fall, a bruise, or a strain; but in acute abdominal affections, beginning with colic, the attention is turned at the outset in an entirely different direction, and indiscretion in diet or an exposure to cold is the first thought in seeking an explanation of the malady. In this field, therefore, the surgeon will do well not to depend upon the spontaneous suggestion of the patient as to injury or violent exertion preceding the attack of appendicitis; he must, in each instance, seek to elucidate an immediate provoking cause by careful, well-directed questioning. If, however, the case has any possible medico-legal bearing, the medical attendant must be guarded in his inquiries so as not to suggest or insinuate that a trauma is the directly responsible agent in producing the malady.

My personal interest in trauma as a cause of appendicitis was first aroused by an incident occurring some twenty years ago, and I believe I cannot better illustrate the change of attitude undergone by the profession relative to the subject during this period than by briefly citing the facts and instituting a comparison between the case and a similar one recently brought to my notice.

During my residence at the Episcopal Hospital in Philadelphia, in the year 1882-1883, a boy of about ten years old was brought into the children's ward suffering from an attack of peritonitis with much pain and fever; his abdomen was tumid, and he was evidently very ill. He stated that he had been struck in the abdomen by another boy, and the illness had followed promptly upon the injury. The boy who inflicted it was being held by the police until the upshot of the case should be known. The little patient died, and the autopsy revealed a perforation of the appendix by a coprolith, with a consequent suppurative peritonitis. At this date, three or four years before Fitz's article had laid the foundations of knowledge of appendicitis, our understanding of such cases was still most imperfect, and at the inquest I asserted with a clear conscience that there was no demonstrable connection between the lesion in the appendix (the manifest cause of death) and the blow which had preceded it; it seemed to be a clear case of *post hoc* and not *propter hoc*, and the boy in custody

was, therefore, at once released. Had I been called upon to testify some years later under the same conditions, my opinion would have been more guardedly expressed.

The second case, which I wish to contrast with this one, occurred in Baltimore twenty years later, and was reported in one of the daily papers (*Baltimore Daily Sun*, July 28 and 29, 1902). A boy, twelve years old, died at St. Joseph's Hospital, after an operation for appendicitis, immediately following a blow upon the abdomen given by a companion during a quarrel. The assailant was arrested on the charge of assault, and then released, but on the death of the patient he was re-arrested to await the verdict of the coroner's jury. The city physician, N. G. KEIRLE, testified that "the autopsy showed inflammation of the appendix which had given rise to appendicitis. The appendicitis could have been occasioned by a blow." There was no foreign body in the appendix. The verdict of the coroner's jury was: "We find that death was caused by appendicitis and peritonitis, but we are unable to say in what manner said appendicitis was caused." The prisoner was, therefore, released. It will be seen that in the twenty years between my first experience and this case, professional opinion had so far advanced that the possibility of a traumatic origin for the appendicitis was readily admitted, although not considered sufficiently established to justify an unfavorable verdict. It is but natural that only the most positive proof should influence a jury to find the defendant guilty under such circumstances.

W. B. SMALL, of Lewiston, Maine, writing upon the relation of trauma to appendicitis (*N. Y. Med. Rec.*, 1898, vol. 54, p. 364), says: "I believe the true cause of the greater percentage of appendicitis in young men is found in the more frequent exposure to accidental injuries and strains, and to the strong contractions of the abdominal muscles necessary in their work. . . . This explanation brings the subject into prominence from a medico-legal point of view. Some cases show plainly the direct results of external violence, and I believe accident insurance companies or corporations and individuals responsible for the occurrence of accidents, are as plainly liable as for a broken limb." This opinion accords with my own. SMALL, six years ago, was able to collect 15 cases of appendicitis occasioned by trauma, from the literature and from individual reports; six years later I found 50 with but little effort. ("The Vermiform Appendix and its Diseases," p. 796.)

I have analyzed this series of 50 cases, keeping in view the following points: Age; sex; previous health; nature, locality, and severity of the injury; evidence of external violence; length of time elapsing between the injury and the first symptoms of appendicitis; severity of illness; evidence of any previous morbid condition of the appendix; and I present here my analysis in tabular form.

ANALYSIS OF 50 CASES OF APPENDICITIS ASSOCIATED WITH TRAUMA, AND, PRESUMPTIVELY, OF TRAUMATIC ORIGIN.

SEX.

Male.....	41 cases
Female.....	8 "
Not mentioned.....	1 case (child)

AGE.

5 to 9 years old, inclusive.....	11 cases
10 " 14 " " ".....	13 "
15 " 19 " " ".....	5 "
20 " 29 " " ".....	11 "
30 " 39 " " ".....	3 "
40 " 49 " " ".....	2 "
Not mentioned.....	5 "

PREVIOUS HEALTH.

Noted as good.....	13 cases
Previous attacks.....	2 "
Not mentioned.....	35 "

NATURE AND LOCALITY OF INJURY.

Blows.....	24 cases
Falls.....	6 "
Exertion.....	20 "

EVIDENCES OF EXTERNAL VIOLENCE, SUCH AS CONTUSION OR LACERATION. Not noted in any instance.

LENGTH OF TIME AFTER INJURY BEFORE DEFINITE SYMPTOMS OF APPENDICITIS APPEARED.

Immediately.....	24 cases
Few hours.....	13 "
One to two days.....	5 "
Two to three days.....	2 "
One week.....	1 case
One to two weeks.....	1 "
Two weeks.....	1 "
One month.....	1 "
Two years.....	1 "
Not mentioned.....	1 "

SEVERITY OF ILLNESS.

Severe at outset.....	26 cases
Mild " ".....	12 "
Severe symptoms followed by interval and recurrence.....	12 "

EVIDENCES OF PREVIOUS MORBID CONDITIONS IN THE APPENDIX.

Foreign body in appendix.....	30 cases
Adhesions.....	7 "
Flexion.....	1 case
Size abnormal.....	1 "
Cystic.....	1 "
Not noted.....	10 cases

AGE AND SEX.—A large proportion of these traumatic cases (29 in 50) occurred between the ages of five and twenty, as we naturally would expect, owing to the greater liability of the young to such mild accidents as blows and falls, and to the more exposed condition of the appendix in child-

hood, where it is covered only by the tender, thin abdominal walls. The fact that there are 41 males to 8 females (the sex in one case is not stated) accords well with the marked difference in the sexes in their habits of life.

PREVIOUS HEALTH.—In most of the cases I have collected, the previous health is not noted, except where it is stated as good. In this respect the results of my analysis have not substantiated my expectations, for I had anticipated finding that a trauma would often prove to be the exciting cause of a recurrent attack of appendicitis. In only two cases in my collection, however, is there any record of a preceding attack. Further investigation would, perhaps, bring other cases to light.

EVIDENCES OF EXTERNAL VIOLENCE.—My statistics do not furnish a single record of any marks of violence on the surface of the body, such as contusions, abrasions, or effusion of blood and discoloration of the skin. I believe, however, that hitherto the fact has not been considered of sufficient consequence to note, and that more careful examinations in the future and more detailed reports will show that in many cases the blow left some mark on the surface, if only a slight one.

NATURE AND LOCALITY OF THE INJURY. — The character of the injury is of three kinds: *blows, falls, or muscular exertion.* The *blows* are either kicks or violent impacts with the fist, given in the course of quarrels. One case in which a little girl, six years old, was kicked in the abdomen by a boy, is a typical example of this class. Another case is of somewhat different character, being a contusion of the deep viscera by forcible impact due to a crushing force rather than a blow. A youth of nineteen, working in a coal-mine, was caught and squeezed in the abdomen between two coal-wagons; symptoms of appendicitis appeared a month later, followed by obstruction, and after repeatedly improving and then relapsing, the patient died at the end of six months. The autopsy showed a constriction of the end of the ileum, from a fibrous band two and a half inches long, passing from end to end of the appendix to the mesentery. There were signs of subacute inflammation above the appendix, at the distal end of which was a cyst. It will be noted that in all cases the injuries were inflicted by blunt instruments, and therefore liable to injure the parts for a distance around the appendix as well as the organ itself. In such cases the important question to be determined is whether there is an increased vulnerability of the appendix, owing to previous disease or to the presence of a foreign body in the form of a concretion.

The traumata coming under the head of *falls* are of two kinds: those in which the patient in falling strikes himself violently against the region of the appendix, in which case the injury is, of course, due both to a blow and a fall; and those in which there is no violent impact in the neighborhood of the appendix, but the shock *per se*, or the sudden translation of the viscera, followed by instant arrest, results in the tearing of some attachment or of adhesions. One case, in which appendicitis followed a fall upon the buttocks, is a good illustration of this class. The numerous cases which follow on violent or prolonged exertion are also, perhaps,

examples of trauma in a somewhat different sense, and I here enumerate the various sorts of strain and fatigue noted in my collected cases in order to show the variety of forms under which this particular kind of trauma may occur. Skipping rope backwards forty times, making a revolution of the rope each time; dancing (2 cases); violent shaking of the body with the head downward; long hunting, over-exertion and fatigue; lifting heavy weights (2 cases); unusually long bicycle ride (2 cases); jumping (2 cases); rowing; playing foot-ball; severe strain while operating.

The trauma in these cases cannot depend upon any blow or impact upon the appendix, for it is inconceivable that the soft, surrounding structures should be capable of inflicting such injury. We are, then, limited to the inference that the exertion has been the direct cause of the injury by rupture of adhesions; or, as in the case of the boy hung up by the heels, of rupture of the anatomic attachments of the appendix; or that a foreign body lying in the appendix has shifted its position so as to bring on an attack.

LENGTH OF TIME ELAPSING BETWEEN RECEIPT OF INJURY AND DEVELOPMENT OF APPENDICITIS.—In the large majority of cases pain was complained of immediately or else within a few hours. It is noticeable that whenever an interval of weeks or months elapsed between the accident and the well-defined symptoms of appendicitis, there were more or less well-marked symptoms of continuous digestive disturbance, or, on the other hand, there was a history of repeated attacks following the injury and before the patient came under observation for appendicitis.

SEVERITY OF ILLNESS.—Somewhat more than half the cases were severe at the outset and continued so without intermission; in about 25 per cent. the initial attack was followed by an interval of relief, while in the remainder the symptoms were mild in the beginning and gradually increased in severity.

EVIDENCES OF PREVIOUS MORBID CONDITIONS IN THE APPENDIX.—The question whether the appendix was normal at the time of the injury which resulted in appendicitis is of considerable importance, for, if the appendix was diseased and therefore liable to an outbreak of inflammation under slight provocation, the status of the defendant in a lawsuit is manifestly altered by the fact. I am indebted to Mr. H. M. BRUNE for the following extract bearing upon the subject from the *American and English Encyclopedia of Law* (second edition, vol. 7, article "Contributory Negligence").

Aggravation of Injury by Plaintiff's Negligence.—While the negligence of the injured person contributing proximately to his injury will bar his recovery of damages, it is held that when he is guilty of no negligence contributing to the injury, negligence upon his part after the injury by which it is aggravated will not prevent him from recovering damages for so much of the injury as the original wrong-doer caused by his negligence. In such cases it seems that the damages may be apportioned or allowance made by the jury for that portion of the injury due to the plaintiff's fault.

Injury Enhanced by Disease.—1. Defendant's negligence causing or aggravating disease. In cases where the defendant's negligence caused a disease, developed a latent tendency to disease, aggravated a prior disease, or led in immediate sequence to disease, the defendant must respond in damage for such part of the diseased condition as

his negligence caused. And if there can be no apportionment, or if it cannot be said that the disease would have existed apart from the injury inflicted by the defendant, then the defendant is responsible for the diseased condition.

2. Diseased condition independent of injury—Defendant's knowledge.—But when the diseased condition exists independently of the injury, and does not flow from it as a natural consequence following in direct sequence, the defendant's liability is only for such consequences as, independently of the diseased condition, were directly and immediately caused by his negligence. Yet if he knew of the diseased condition, and could have foreseen that it would aggravate an injury inflicted by his negligence, he is liable for the entire consequences that flow from the combination of his negligence with the existing diseased condition.

In 40 out of my 50 collected cases the appendix deviated in some way or other from normal, and 30 out of the 40 abnormal appendices were noted as containing concretions; in 7 of the remaining 10, which were without a concretion, there was evidence of old adhesions; of the last 3, 1 was flexed on itself; 1 was cystic; and 1 was unusually short and wide. No case has as yet appeared in which it has been shown that an injury *ab externo* has produced an appendicitis in a previously normal appendix, the presence of a foreign body being taken as indicative of disease, since it is the consensus of the educated medical profession that an appendix containing a fecal concretion is abnormal, although it is true that such an appendix may remain quiescent for an indefinite period. We may, therefore, conclude from the reported cases that a patient who is carrying a concretion in his appendix is far more liable to an attack of appendicitis from a blow of sufficient force when suitably directed than he would be were the appendix in all respects normal. In such a case there can be no allegation of negligence on the part of the plaintiff in bringing about or aggravating his condition, since he must have been entirely ignorant of it until it was revealed by the surgeon's knife. On the other hand, it cannot be said that the disease would have existed apart from the injury inflicted by the defendant, who becomes, therefore, liable for the lighting up of the disease into activity, and is responsible under the clause "developed a latent tendency to disease, aggravated a prior disease, or led in immediate sequence to disease," as above quoted.

In order to determine the degree of responsibility of the defendant it will be necessary to ascertain how much violence was used, and to associate this factor with the previous condition of the appendix, as seen at operation or postmortem, according to the statement made by the physician. In view of the grave consequences to the defendant involved in an action for damages, the physician who examines the appendix and neighboring structures in such a case ought to note carefully the presence or absence of any old adhesions (evidences of previous attacks), of peritonitis, of rupture, of perforation, or of acute strangulation of the appendix. The appendix itself should be most carefully preserved, and preferably in formalin or in Kaiserling fluid, in order to demonstrate any ulcers of the mucous surface, any old scars, or strictures. If the appendix shows signs of old disease, if it contains a large concretion, or if the patient had had previous attacks and it can be shown that but slight force was used,

and that without intent of injury, the status of the defendant will be different from what it would be in a case where no disease was present or one in which much violence was used.

The question of trauma as it affects the liability of life insurance companies becomes somewhat different, since the injury giving rise to appendicitis in these cases is due to exertion on the part of the patient himself, rather than to force in the hands of another. In the absence of a specific exception in the policy, the company ought to own its liability for appendicitis, as for any other internal disease. The only instance in which such company could escape liability would be where it could show that the plaintiff had knowledge of previous attacks or weakness, which he concealed, or failed to state in applying for his insurance, information which, under the terms of his policy, he was bound to furnish.

In the case of accident insurance, the company should be held liable when the appendicitis sets in directly after a blow or a strain.

MEDICO-LEGAL COMPLICATIONS.—As an instance of legal complications relating to an appendicitis, I cite the following case, for which I am indebted to A. E. MALLOCH, of Ontario, Canada:

A young man was attempting to lift a heavy cheese down from a shelf, while standing on a step-ladder, and the added weight causing the ladder to shift its position, forced him to exert himself, and occasioned a violent strain of the abdominal muscles; he remarked at once to those present that he had strained himself seriously. He began to have pain in his side almost immediately, severe enough to keep him in bed, more or less, for three days, after which he improved. On the tenth day, however, he was seized with symptoms of collapse, and died the day afterward. The postmortem examination made by Malloch "showed general purulent peritonitis with a ruptured abscess sac, containing a hard, sloughing appendix" (see Fig. 215). The patient having taken out an accident policy in the Commercial Traveller's Insurance Company, the family presented a claim, which the company refused to pay, because there was no external lesion discoverable. On receiving a letter, however, signed by DR. MULLIN, the physician in charge, as well as by DRs. MALLOCH and OLMSTEAD, who attended in consultation, testifying as follows, they paid the claim: "The deceased immediately after lifting the weight stated that he had been hurt, and subsequently repeated this to all whom he saw. As symptoms which were located in the region of the appendix followed immediately, we have no doubt that the appendix was injured at the time, and that this must be considered of the nature of an accident."

In concluding the subject of trauma, I would emphasize the following points:

Evidence is lacking to show that trauma has caused appendicitis in a previously sound appendix.

An appendix containing a fecal concretion or other foreign body is not sound, and in such a case a severe muscular strain or blow upon the right side of the abdomen may produce a lesion of the mucous or muscular coats sufficient to favor the invasion of pathogenic organisms, giving rise to an attack of appendicitis in no wise differing from the common forms of the disease.

If the patient strains or makes active use of the abdominal muscles at the time of the receipt of the blow, these factors may act conjointly in causing the attack.

The more violent the blow or the greater the strain, the greater is the likelihood of an injury to the appendix.

A blow acts more efficiently upon a person with a shallow or a scaphoid abdomen where the walls are thin, than upon one who is stout or strongly built.



FIG. 215.—CASE OF A. E. MALLOCH, HAMILTON, ONT., IN WHICH ACUTE APPENDICITIS AND DEATH FOLLOWED SEVERE MUSCULAR STRAIN.

The blow acts as the immediate cause in producing the attack, which, while it might have occurred soon without such intervention, also might not have occurred for some years; the mediate cause is usually a foreign body.

Whenever a physician is called to a case the history of which is suggestive of traumatic origin, he will do well to make careful notes at the time, quoting as far as possible the patient's own language and expressions relating to the following facts:

1. The nature of the injury, whether a blow, a fall, or a strain.
2. The agent producing the injury.
3. The exact point and manner of impact, and whether the patient was engaged in active exertion or straining himself at the time the injury was received.
4. The expressions used by the patient at the time and the nature of his immediate complaints.
5. The length of time elapsing between the injury and the call for medical aid.
6. Any external evidence of violence (to be noted most carefully).
7. If an interval of some weeks has elapsed, an inquiry into the condition of the patient during this period should be made, it being stated whether he was able to resume his ordinary occupations, and with or without distress.
8. If death ensues or an operation is performed, it is of the highest importance to record the exact condition of the peritoneum and the viscera underlying the injured area, a minute and careful statement regarding the presence or absence of fecal concretions being always recorded.

The following case, in which a concealed trauma and infection were suspected, is of great medico-legal interest. It was reported by H. M. BIGGS to the New York Pathological Society as an instance of suspected criminal abortion which proved to be appendicitis.

The patient, an unmarried servant, was suddenly seized with severe pain during a menstrual period. The attending physician discovered a general peritonitis, and associating this fact with the occurrence of an excessive menstrual flow, and "some evidence of a circumstantial character," concluded that the case was one of criminal abortion, and so reported it to the Board of Health. The woman died, and the autopsy revealed a general peritonitis resulting from a perforation of the appendix about one and a half inches from its base; a small, hard mass of fecal matter was found in the peritoneal cavity.

I hope that enough has been said to convince my professional colleagues that appendicitis must always be regarded as an affection for which an active human agency can be responsible, and that testimony to that effect must be given when the facts warrant it, with assurance, whether it be for or against an individual or an association.

It is the duty of every physician, in taking the history of all cases of appendicitis, to inquire carefully into antecedent blows, falls, or unusual exertion, and to listen with attention to any suggestion made by the patient which points in that direction. He must also bear in mind that the injury need not necessarily be of recent date, although some symptoms, it may be of a vague character, will probably be recalled as immediately following it.

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